SHARING WATER

Irrigation and Water Management in the Hindukush – Karakoram – Himalaya

Edited by
Hermann Kreutzmann

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Abbreviations and Acronyms

ACAP	Annapurna Conservation Area Project
AD	Agriculture Department
ADO	Agriculture Development Officer
AKF	Aga Khan Foundation
AKRSP	Aga Khan Rural Support Programme
a.s.l.	above sea level
ASMS	Assistant Subject Matter Specialist
CAD	Command Area Development
CO	Coordinating Officer
FAO	Food and Agriculture Organization
f.n.	footnote
FODP	Farmer Organization Development Programme
GTZ	German Society for Technical Cooperation (Gesellschaft für technische Zusammenarbeit)
HALWDP	Hill Areas Land & Water Development Project
ICIMOD	International Centre for Integrated Mountain Development
IIMI	International Irrigation Management Institute, recently renamed into International Water Management Institue (IWMI)
IOL	India Office Library, London
IOR	India Office Records, London
IPH	Irrigation & Public Health
IRR	internal rate of return
ISPAN	Irrigation Support Project for Asia and the Near East
IVD	Interactive Video Disk
KVS	Krishak Vikas Sangh (Irrigation Farmer Organization)
LCU	Liaison and Coordination Unit
NAPWD	Northern Areas Public Works Department
NGO	non-governmental organization
PET	potential evapotranspiration
PPI	physical productive infrastructure
PRO	Public Record Office, London
RD	Rural Development Department

RGOB	Royal Government of Bhutan
SOAS	School of Oriental and African Studies
SHYDO	Small Hydroelectricity Development Organization
SMS	Subject Matter Specialist
USAID	United States Agency for International Development
VEO	Village Extension Officer
VO	Village Organization
VPG	Village Production Group
WALMI	Water and Land Management Institute
WAPDA	Water and Power Development Authority
WO	Women Organization

Preface

The idea for this book originates in a proposal by Corneille Jest many years ago. He suggested to collect substantial information on water management and irrigation in the mountain arc of High Asia in order to enable an exchange of knowledge and experiences among scholars and practitioners working in this region. Unlike on other occasions we refrained from organizing a conference as a meeting for the presentation of papers. Instead all probable contributors were contacted personally and invited to participate. Exchange of information between Almora, Baltimore, Berlin, Braunschweig, Chitral, Erlangen, Gilgit, Heidelberg, Kathmandu, Luxembourg, Peshawar, Montpellier, Paris, Simla used all available means of traditional and modern communication technologies. Presenting this compendium numerous meetings and exchanges of letters, revisions of manuscripts and re-drawings of illustrations result in one book which has been written in different word processing programmes, on disquettes of heterogenous and somehow compatible operating systems and sizes. The technical problems had been underestimated compared to the communication abilities among contributors. Due to the untiring efforts of Andrew Manzardo manuscripts were put in one format and a consistent ductus. The interest in irrigation has been the binding force of all contributors and we are convinced that knowledge about water management has further to be increased. This is one step forward and I would like to thank all who have participated in this effort from conceiving the idea towards producing this book. If it stimulates the discussion about the resource use in mountain areas and points out the trans-disciplinary approaches needed one little step might have been achieved.

Hermann Kreutzmann
Erlangen, July 1998

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Abstracts

HERMANN KREUTZMANN: WATER TOWERS OF HUMANKIND—APPROACHES AND PERSPECTIVES FOR RESEARCH ON HYDRAULIC RESOURCES IN THE MOUNTAINS OF SOUTH AND CENTRAL ASIA

This introductory paper presents a conceptual framework for the analysis of water management practices and irrigation systems. Practical approaches are suggested for the development of research into the hydraulic resources of arid zones in the mountain irrigation systems of South and Central Asia and the basic ecological conditions, such as precipitation patterns and gradients, glaciation and vegetation cover are evaluated, along with their relation to the human sphere of everyday agricultural work. These form the background for the analysis of the socio-economic aspects of water management as an important step towards the understanding of the institutional factors of irrigation and their relevance for sustainable development. This three-dimensional systematic approach, looking simultaneously at geo-hydrology, ecology and human institutions, offers a framework in which the case studies can be incorporated.

VINCENT FOURNIAU: SOME HISTORICAL NOTES ON IRRIGATION IN CENTRAL ASIA

This paper argues that irrigation deserves to be considered as a primary factor in the exploration of Central Asian history. The richness of irrigation history easily matches what any written source offers socio-economic historians in other areas. The paper starts with a presentation of the major types of irrigation found in the core of Central Asia, Transoxiana, and touches upon a variety of aspects of the irrigation of the region where it has been used throughout history. In this discussion, many examples are taken from the Xvârezm region, one of the biggest oases located on the left bank of the lower stream of the Amu Daryâ river, complemented by examples taken from other regions of Transoxiana where sedentary, and particularly urban civilization blossomed for centuries due to artificial irrigation.

Irrigation networks bear witness to military conquest and political change. As Transoxiana is located at the centre of Asia, its lands and irrigation systems have been in jeopardy to many great powers over time, either as heartland, or as borderland. Military and political competition have a central factor in its history, either in periods of large world conquest such as the Mongol invasions, or in small skirmishes between local rulers. The repeated destruction and rehabilitation of the irrigation network can be traced through archeological excavations, and illuminates a history that no in-depth study can ignore. Linkages between the written sources of political rulers and the cultural elites of Central Asia or from the empires that dealt with it, each draw their own various biased pictures of this historical development, undermining or overlooking many facets of always very complex situations. The study of irrigation is an indispensable source of information to try to determine what actually occurred, particularly in topics concerning sedentary and nomadic exchanges as a whole and to shape an overview of the area's long-term evolution.

Irrigation also possesses a great cultural dimension; an astonishing conservatory of the vocabulary and institutions which enabled these systems to be managed over time; an area where continuity far surpasses disruption. In short, the paper illustrates that the study of irrigation contributes to the development of our knowledge and understanding of Central Asia, the least known of the major cultural zones of Asia.

ISRAR-UD-DIN: SOCIAL ORGANIZATION AND IRRIGATION SYSTEMS IN KHOT VALLEY, EASTERN HINDUKUSH

This paper presents a case study of the irrigation and water management practices of a village in the Hindukush region of Chitral District, Pakistan. Stating that socio-economic, agronomic and ecological factors frame the conditions for irrigation, the paper presents a detailed survey of the general features of the system and its local peculiarities. The structural aspects of the network are discussed through a discussion of the system's water distribution rules and regulations. The hierarchy of different channel systems, the structural problems of the network as well as aspects of its own social organization, its water rights and their implementation are highlighted.

GEORG STÖBER: IRRIGATION PRACTICE IN YASIN, NORTHERN AREAS OF PAKISTAN

This case study on irrigation in the Yasin valley (Northern Areas of Pakistan) attempts to determine which social units are involved in each of the various aspects of water management as well as the extent and the causes of variability in these irrigation systems. The study shows that title for water is established through the household, which figures as the smallest unit of water distribution regulation and of co-operative working groups for construction and maintenance of irrigation canals. Above the household level, the social organization of irrigation varies. Informal or more organized co-operation at an irrigation group or village level are to be found, as well as more formalized systems with their own specialized offices (*asaqal* and *dalakuin*), which seem to be determined not only by the size of the systems, but by the strong influence of a central authority. Generally the variability can be attributed to differences in the availability of water, as well as to the size, complexity and historical development of a particular system. When exceptional circumstances interrupt irrigation, (e.g. mud slides), *ad hoc* crisis management may incorporate social groups and institutions generally unconcerned with irrigation matters.

HERMANN KREUTZMANN: WATER MANAGEMENT IN MOUNTAIN OASES OF THE KARAKORAM

Water management as a means of increasing the productivity on marginal lands forms an important strategy for development planners in tropical and subtropical regions. As long as big scale projects dominated development strategies, emphasis has been mainly put on lowlands. This case study focuses on the development of highland irrigation networks and its relationship to social organization in a mountainous region of the Karakoram which in recent years has become the target of different development agencies.

Agriculture in this ecological zone requires regular irrigation for field crops as the average precipitation on the valley floors never surpasses 150 mm per annum. The paper elaborates the expansion of the irrigation network in a diachronical analysis, and gives an insight into the socio-political impact of its different historical phases. Food shortage, as well as limited water resources for irrigation, has resulted in a sophisticated system of rules regulating the access to water and its distribution among clans and/or villages. An external transformation of this system has been evolving since the deposition of the local rulers of the area in 1972–74. The resulting

power vacuum which occurred affected the irrigation system as well as the rest of the local institutions of the area. This called for a changed approach. Development agencies are now supporting village organizations which nowadays are planning and executing irrigation projects for their own communities. Acknowledging local expertise and participation in the expansion of cultivated lands promises a stabilization of existing irrigation networks in the Karakoram.

ANNA T. SCHMID: MINORITY STRATEGIES TO WATER ACCESS: THE DOM IN HUNZA, NORTHERN AREAS OF PAKISTAN

Since agricultural activities in the arid settlement zone of Hunza totally depend on irrigation, the water management system is a critical factor of the economic system and consequently for other spheres of life. Taking this into account, the study reveals how a minority group, the Dom, whose primary resources are derived from artisanship, attempts to gain new resources in the agricultural sphere through an attempt to gain increased access to the irrigation system. This case study presents the strategies applied by the Dom in a water dispute and shows how they adjust their strategies to different political, economic, and legal circumstances. Despite their failure to achieve their main objective of increased entitlement to water resources, the Dom nevertheless gain support from important lobbies and respect for their tactical behavior. Firstly, they are acknowledged for their skills which are directly related to their artisanship and secondly, they are recognized as a minority to be reckoned with in other than their traditional spheres.

HUSSAIN WALI KHAN AND IZHAR ALI HUNZAI: BRIDGING INSTITUTIONAL GAPS IN IRRIGATION MANAGEMENT: THE POST-"IBEX-HORN" INNOVATIONS IN NORTHERN PAKISTAN

This paper is about small, farmer-managed irrigation systems found in the mountainous northern regions of Pakistan. It describes and analyses the changes brought about through their interaction with the Aga Khan Rural Support Programme (AKRSP). In particular, the paper examines the relationship between participatory social organization and effective systems for local management of common village resources including land, water, and irrigation channels. The paper also explores the broader issues of policy, technology and investment in the irrigation sector, in the context of local planning and development. The primary focus is on capacity-building through institutional renewal at the grassroots level. In support of this perspective, the paper presents AKRSP's cumulative experience in rural engineering and irrigation management. The evidence is drawn from 589 small, AKRSP-supported irrigation projects implemented and managed by the Village Organizations (VOs), over a ten-year period.

ROHIT VOHRA: NOTES ON IRRIGATION AND THE LEGAL SYSTEM IN LADAKH: THE BUDDHIST 'BROG-PA

This paper presents a brief account of the irrigation projects implemented over the last decades under the auspices of the Desert Development Agency in Ladakh. It provides an overview of modern irrigation systems in the area. Ladakh is characterized by high mountain ranges interspersed with valleys having a steep and rocky terrain with little or no soil. Agriculture is possible, for the most part, only along the banks of streams and rivulets, and it is greatly dependant on temperature and precipitation each year. Aside from parts of Nubra, the Buddhist 'Brog-pa area is the only part of Ladakh which is warm and comparatively fertile, allowing a great variety of fruit and vegetables to be grown and for two crops to be harvested in a year. Linguistically the Indo-Aryan 'Brog-pa, often referred to as Dards, maintained a grass-root level land redistribution system until the turn of the century, dependant upon the evolution of their closed village community.

VALERIE LABBAL: TRADITIONAL OASES OF LADAKH. A CASE STUDY OF EQUITY IN WATER MANAGEMENT

Ladakh is located in the rainshadow of the Himalayas and receives less than two hundred millimetres of annual precipitation. This paper looks at the oasis of Sabu, which is located in the upper Indus valley. The irrigation system of Sabu is an example of an elaborate system to control available water resources. Water distribution is divided into two major periods. The first is a period of scarcity, which requires a highly sophisticated turn system in order to safeguard equal shares for all community members. The second, the end of scarcity after the commencement of the flood, allows rules and regulations to be relaxed to such an extent that no personal supervision is required anymore. Sharing all responsibilities within the community guarantees the equity.

ANDREW MANZARDO: FARMER PARTICIPATION IN IRRIGATION MANAGEMENT IN STATE-SPONSORED MINOR IRRIGATION SYSTEMS IN THE INDIAN HIMALAYAS

Although there are water user groups currently involved in the management of literally hundreds of traditional irrigation schemes in India, the number of irrigation schemes which are either totally farmer managed, or involve farmer participation in some aspect of system management cover less than one per cent of the total irrigated area of the country. In order to increase this area under farmer management, farmers would have to be given a greater role in the management of state-sponsored irrigation.

The reasons for increasing farmer participation in irrigation management have been widely discussed and generally center in the following areas:

- relief to the government of part of the costs and burden of system management (especially minor maintenance, rule enforcement and the solving of water disputes);
- improvement of system performance due to increased co-operation between farmers;
- improvement of micro-network system maintenance; and
- improvement equity of water distribution.

The paper discusses the Hill Area Land and Water Development Project (HALWDP), which experimented with a model for a system of confidence building and interaction between the groups and began the work of its institutionalization within the regular government system. Such a system requires the formation of a temporary group of facilitators to bring the groups together, mediate their differences and start them on a single set of tasks. Such an approach requires training for farmers, for irrigation staff and government officers. Mutually acceptable systems of work have to be developed and a legal and institutional structure established to protect the rights of those participating. HALWDP tried to handle each of these tasks simultaneously on a pilot level, and develop the training programmes and identify actors in order to expand the system to the government of the state as a whole.

CORNEILLE JEST AND MARC POLGE DE COMBRET: IRRIGATION IN DOLPO: AN EXAMPLE OF WATER MANAGEMENT IN A STEPPIC ZONE OF NORTHERN NEPAL

This paper looks at the Himalayan District of Dolpo in north-west Nepal, above 4000 m altitude, inhabited by a population of Tibetan culture, where agriculture is only possible with irrigation. The climate is harsh with very low temperatures in winter and a short warm season from May to August. The rainfall is less than 250 mm a year. The only grain cultivated is barley of the six rowed naked variety. The water necessary for cultivation is tapped from streams and distributed by a network of canals to the fields located on alluvial terraces. The poor quality of the soil for gravitational irrigation with a high infiltration rate is balanced by irrigation methods using very small basic patches in the field. Water management is controlled by the users according to elaborated rules. When water is scarce, the shares are drawn by lots. The farmers of Dolpo have found a sensible compromise from empirical experience. Improvements or expansion of the irrigation network would entail extensive studies and serious financial support.

MONIQUE FORT: NATURAL CONDITIONS AND HAZARDS FOR IRRIGATION IN THE ARID HIMALAYA OF UPPER MUSTANG DISTRICT, NEPAL

Upper Mustang (northern Nepal) is of particular interest in the context of arid, northern Himalayan areas. Its exceptionally harsh environment and dissected topography make the geo-ecological conditions of irrigation and the potential natural hazards quite severe. After a short presentation of this area and of the specific physical conditions of irrigation, the paper documents the water supply hazards with respect to climate and soils. Emphasis is given to geomorphic hazards, i.e., rill and gully erosion, mass-wastage features and seismotectonically induced instabilities causing extreme catastrophic events. Recent changes observed in local economic conditions may have revealed potential schisms in various sectors of the area's diverse population which could modify the local peoples' perceptions of potential resources, an evolution which makes the future of the water management system of Mustang quite uncertain.

OLIVIA AUBRIOT AND JEAN-LUC SABATIER: DRYLANDS IRRIGATION IN A WETLANDS AREA: THE EXAMPLE OF ASLEWACAUR IN CENTRAL NEPAL

Water management techniques must not be systematically interpreted as a response to ecological conditions. The present case study precisely shows a water management system similar to that observed in arid areas, but surprisingly is one located in an area exposed to monsoon influence. The study demonstrates that the presence of such a system in this region can be understood, on the one hand, by technical borrowing, but on the other hand its presence can be explained through the social efficiency of the system itself.

CORNEILLE JEST: WATER RIGHTS IN BHUTAN. LEGAL ASPECTS

In Bhutan, despite a significant rainfall, irrigation is necessary for rice cultivation. The water management regulations derive from community rules and have their place in the Bhutanese code of laws, put in a written form in 1957. The paper discusses the various aspects of these rules, ownership of land and water, maintenance of canals, distribution of water which are included in these "laws concerning the soil".

2

Introduction

Hermann Kreutzmann

This volume was compiled because a group of contributors perceived the lack of a transparent approach to development problems relating to "sharing water" in the Inner Asian mountain barrier and a lack of interdisciplinary communication about research in the field. Important findings in geo-ecology, for example, often escape the notice of sociologists, anthropologists and economists and all too often the reverse is true. Language barriers further increase the difficulties of communication. Yet, a holistic approach is required to understand the background and functioning of highly sophisticated irrigation systems. Further, it is hoped that a dialogue between scientists and development practitioners can be encouraged through the contributions to this compendium, as both should depend on each other in their respective work.

The authors of the case studies presented have focused their research on vast oral traditions, seldom written-down, which incorporate the technological and organizational knowledge of many generations of farmer irrigators. This is particularly important in a period where there is a growing emphasis on finding ways to turn over the management of increasingly complex irrigation systems, in part or as a whole, directly to farmers. Not only does this book attempt to increase available information about traditional irrigation management systems and present a survey of recent research, providing the reader with ample evidence that farmers can and do already manage complex irrigation systems on their own, but it also provides some insight as to how such information can be used to support this transition in other communities no longer still practising such farmer control.

Another aim of this volume is to provide a source for investigation into existing studies published in various languages, scattered sources, grey literatures, progress reports and base-line surveys, many of which are located in remote documentation centres. All contributions are presented in a

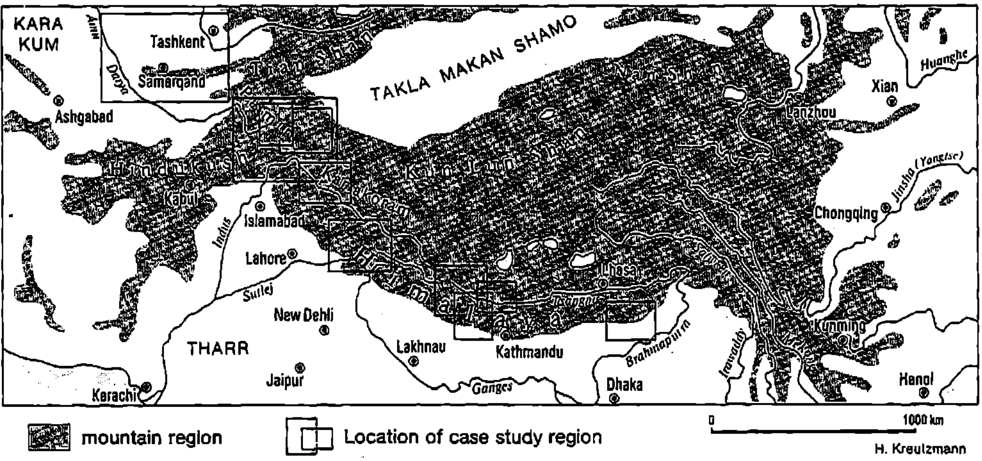

Figure 2.1: High Asia: location of case studies.

regional rather than in a thematic or sectoral order. Studies are therefore presented in a geographical sequence of west to east (Fig. 2.1): beginning with studies of traditional water management in Uzbekistan and Tajikistan; then to irrigation in Pakistan; followed by studies concerned with water-related practices in India; ending with contributions from cases in Nepal and Bhutan. The case study which makes up each of these chapters has its own bibliography.

The case studies are preceded by a chapter on the "water towers of húmankind" in which the general features of water resources in the area under study are presented along with a theoretical framework for a systematic approach to irrigation studies. The subsequent contributions can be broken down into four classes:

Two papers are concerned with water management from an historical perspective. In the first paper, Vincent Fourniau highlights research deficits in Turkic and Tajik speaking regions of Central Asia. Most of the research presented here has so far only been published in Russian. He provides us with some insight into the Central Asian river regimes and how they effect water management practices. The irrigation technology and its linkages to social organization are discussed in an historical framework, emphasizing the difference between sedentary and nomadic water-users. The paper investigates the importance of water management for social development from a longer historical perspective, providing a framework for individual cases on a local and regional level. A second paper by Rohit Vohra provides a transition between historical investigation and regional case studies through an examination of the connection between water management and traditional law over time in Ladakh.

The majority of the papers are case studies based on empirical field research, yet all of them provide necessary historical depth. Georg Stöber, for example, presents a case from a valley society in the Hindukush where he examined the development of irrigation practices in an arid environment. He points out that scarcity of water, as well as natural and human constraints pose limiting factors on an irrigation system where maintenance requires substantial inputs, both regular and irregular, from the local work force. Hermann Kreutzmann illustrates the communal approach to managing a valuable and hard to control resource in the Karakoram valley of Hunza. Physical obstacles, a growing demand for water and conflicting interests are reflected in the codification of water rights. In contrast to common expectations these are not fixed and unchangeable. The evolution of water codices shows adaptive strategies and a flexible approach to community demands and socio-political conditions. Valerie Labbal has chosen a different regional context for her case study; a village in Ladakh that commands the water resources of a stream discharging meltwater to the village lands. She has ventured a reconstruction of the development of this irrigation network by simultaneously evaluating agro-ecological and social implications. Corneille Jest and Marc Polge in collaboration with Trangmar Pema have studied the water management in the steppic Dolpo area of western Nepal, an extremely harsh environment at high altitude. This sets the stage for an adaptation to ecological conditions which allows only limited forms of crop cultivation. Nevertheless, agriculture in the area requires irrigation and local social organization defines its methods. In the context of such harsh environments Monique Fort contributes the viewpoint of a physical geographer investigating the constraints for irrigation in Mustang District of Nepal. Here, certain preconditions embedded in the geological structure and geomorphology challenge the local peoples' ability to adapt to an extremely arid environment. These natural hazards pose a recurrent threat to any use of cultivated land, irrigation channels and their sources of water. Olivia Aubriot and Jean-Luc Sabatier examine in the Middle Hills of Nepal, where more humid conditions prevail. In this case study, the community's own methods for allocating water are looked at from the perspective of an individual farmer's requirement for additional water.

Strategy papers and evaluative contributions from development practitioners are presented in this volume in order to provide a link between approaches between the study of traditional water management and the extension of these approaches to the social and agricultural sciences and to development projects. Both contributions presented here aim at bridging the gap between long-term research and short-term decision-making in the field. Hussain Wali Khan and Izhar Ali Hunzai highlight how non-governmental institutions could fill an administrative vacuum by introducing village organizations to irrigation management. These co-operative institutions formed a nucleus for village decision-making which initially focused on the improvement of the physical infrastructure systems through irrigation projects in the Hindukush-Karakoram. They show the success of an innovative approach which incorporates the local knowledge of water management and local structures of co-operation as two major preconditions for any sustainable rural development. Andrew Manzardo shows the strategic impact and administrative co-operation between agents of development and public institutions in Himachal Pradesh. This study provides insight into the importance of institutional development for the structural sustenance of irrigation projects.

Another set of papers concentrates on the legal aspects of water management either through a commentary on the existent irrigation codification (in Bhutan), or through a discussion of conflict resolution between users and administrative institutions (in Pakistan). Anna Schmid reconstructs the sequence of a legal dispute over water use between a minority and a majority group in Central Hunza. In the conflict, a hereditary ruler and highest authority for the irrigation system, was replaced by state authority when several insoluble disputes arose. Different arguments and approaches are presented in her study based on court documents. Corneille Jest shows how the public water law of Bhutan is based on former oral traditions and common-law which did not require certain forms of codification. This is an exceptional case where state legislation reflects a common heritage of resource management.

3

Water Towers of Humankind: Approaches and Perspectives for Research on Hydraulic Resources in the Mountains of South and Central Asia

Hermann Kreutzmann

The opening remarks of the "Appeal for the Mountains"[1] refer to mountains as the "water towers to modern civilization". This view especially holds true for the mighty wall of ranges separating the Inner Asian deserts and the steppes from the plains of the Indian subcontinent. The Hindukush-Karakoram-Himalayan arc provides valuable water resources for some of the most extensive irrigation oasis networks on earth (Fig. 3.1). The conveyance of meltwater from the nival zones to the low-lying deserts of the plains areas has a long-standing tradition and is responsible for man's ability to utilize arid zones in the vicinity of mountains. Gravity is the driving force, and rivers are the long distance conveyance lines for this valuable resource. The extension of irrigation networks, the construction of dams and the generation of hydro-energy have increased over time, and have contributed to the integration of mountain regions into supra-regional exchange patterns. The interdependence of lowland and highland societies is expressed through access of rights to the utilization to this water, a strategic element, which has sometimes led to conflict.

The above mentioned extensive irrigation networks of the plains are highlighted, first of all, when referring to water management in Asia. The inhabitants of the arid and semi-arid mountain regions, on the other hand, also depend on irrigated agriculture to a substantial degree in order to safeguard their own survival within their high-altitude habitat. Different approaches to the utilization of local water resources can be observed in

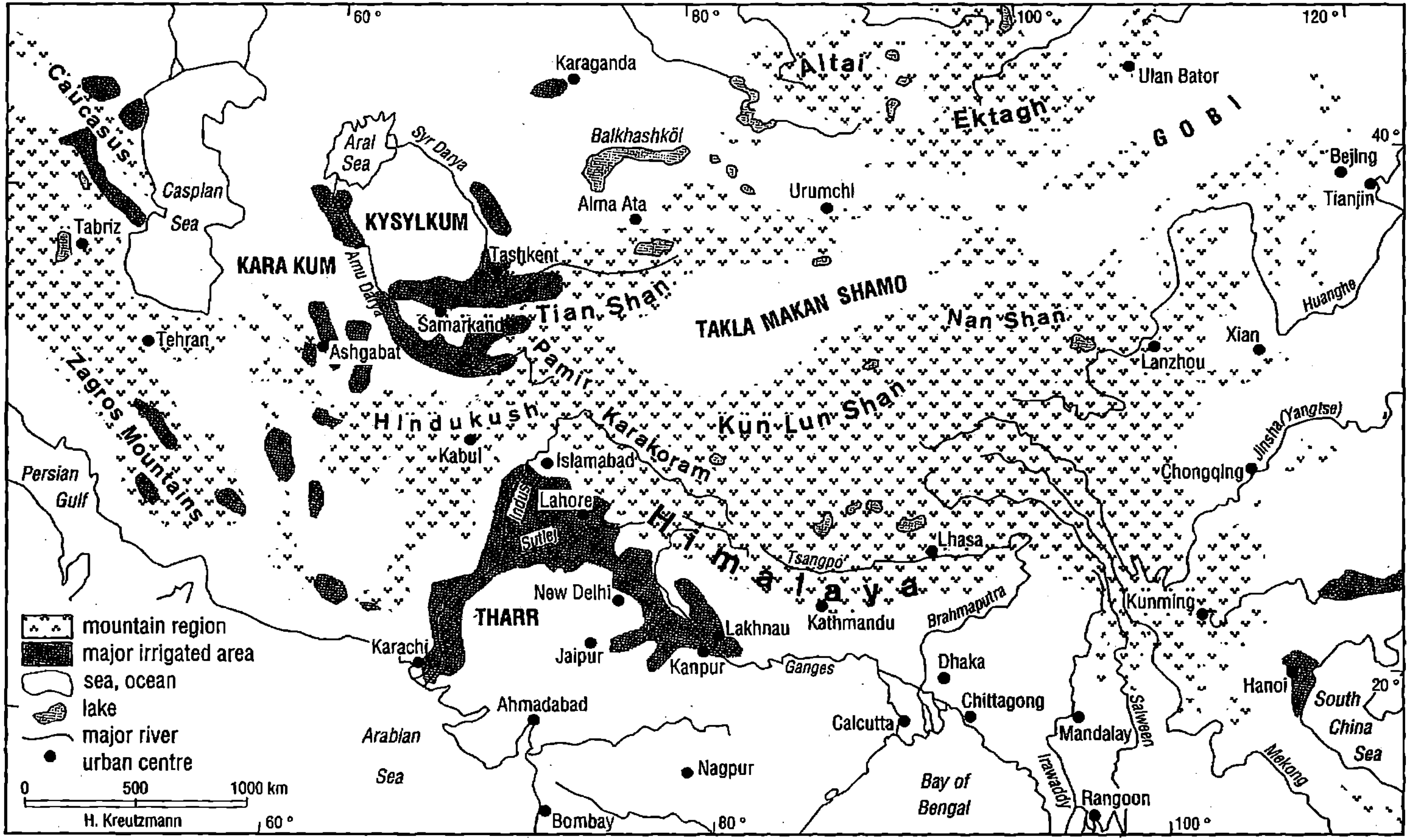

Figure 3.1: Mountains of Central Asia.

these remote regions; and some of the most ingenious and highly sophisticated decentralized irrigation systems form the basis of communal life at this upper limit of human habitation. Such types of expertise, both irrigation techniques and institutional patterns, are only common knowledge to the user communities and are generally unrecorded by outside specialists. Water management forms an integral part of local culture and reflect its social and communal structures. Specific rights and duties are embedded in local oral traditions and passed from generation to generation, but having evolved in a harsh environment they modified according to circumstance.

Although this knowledge had been widely neglected in the push to modernize in the early development decades, the circumstantial failure of many of these externally induced development programmes to reach their targets of participation, production and sustainability has stimulated a search, in recent years, for a greater awareness and understanding of local conditions and these older traditions. Nevertheless, the wealth of experience and related techniques of water management encapsulated within existing small-scale irrigation systems are still prone to be neglected when development projects are begun.

Technological progress, improved materials, financial aid and the political backing of administrative bodies are strong powers attempting to supplant existing user communities to develop “their” agriculture. One is confronted with competition between different approaches to development in the present period, where the pace of change seems quite fast. Researchers oscillate between their desire to understand local techniques and social institutions, on the one hand, and rapidly implement development programmes through the application of blue print approaches on the other.

Irrigation development seems to follow a characteristic three-stage process. Traditional water management strategies in remote mountain regions first develop as the result of an adaptation process to social and environmental conditions. As the socio-economic pressure on local resources grows and exchange relations between highlands and lowlands are augmented enhancing the permeability of local societies and their structural setups. This is followed by external funding from public and supra-regional resources of the wider community, enabling projects to be implemented which would have been declared unfeasible under local considerations. Finally, the failure of these projects results in increased external efforts from NGO and other public institutions in planning and development exercises which call for more local participation and take into account the original traditional approaches of farmers to some degree refurbishing their traditional institutions to enable them to participate, but in a new institutional context.[2]

Attempts to establish sustainable and equitable development by using appropriate technologies go back to making appropriate use of fundamental local knowledge. Some materials have been presented in scattered publications[3], but an overview of the spectrum of autochthonous methods of communal resource management and their interrelationship with, or impact on, social organization is still lacking. The intention of this compendium on water management is to treat the Hindukush-Karakoram-Himalayan arc as a region of diversity from which different approaches on the use and sharing of water resources from these great water towers are reported in case studies as well as in strategy papers from irrigation development projects.

THREE-DIMENSIONAL APPROACH TO WATER MANAGEMENT

Water management is concerned with the energy-efficient transportation of hydrologically exploitable resources from the upper zone to climatically favourable areas, where irrigation helps to supersede arid conditions for the cultivation of crops and watering of meadows. In other words, human intervention sets the stage for the collecting and direction of water from a wider catchment area to a smaller habitat where this resource is deficient.

Emphasis on the montane irrigation practices of this introductory chapter, is counterbalanced with developments in the lowland areas, which have a different background and their own development problems. The contrast between highlands and lowlands is highlighted in order to accentuate the specific approach of this collection. In dealing with the importance of water from the mountain regions three dimensions have to be judged:

- natural factors and their relation to the environmental framework and the processes of technological adaptation,
- social factors and their impact on culture, economy and equity,
- institutional factors and their importance to sustainable growth and the implementation of development projects.

Human activities in arid mountain regions are restricted by limiting ecological factors and are characterized by certain strategies of utilization and adaption. In the study of decentralized irrigation systems of high mountain regions, a system's theoretical approach values the complexity of interrelationships between the different system elements (Fig. 3.2).

WATER MANAGEMENT IN HIGH MOUNTAIN REGIONS OF CENTRAL ASIA

The 3000 kilometre-long mountain barrier separating the Indo-Pakistan subcontinent from Inner Asia creates a major climatic divide. Monsoon-

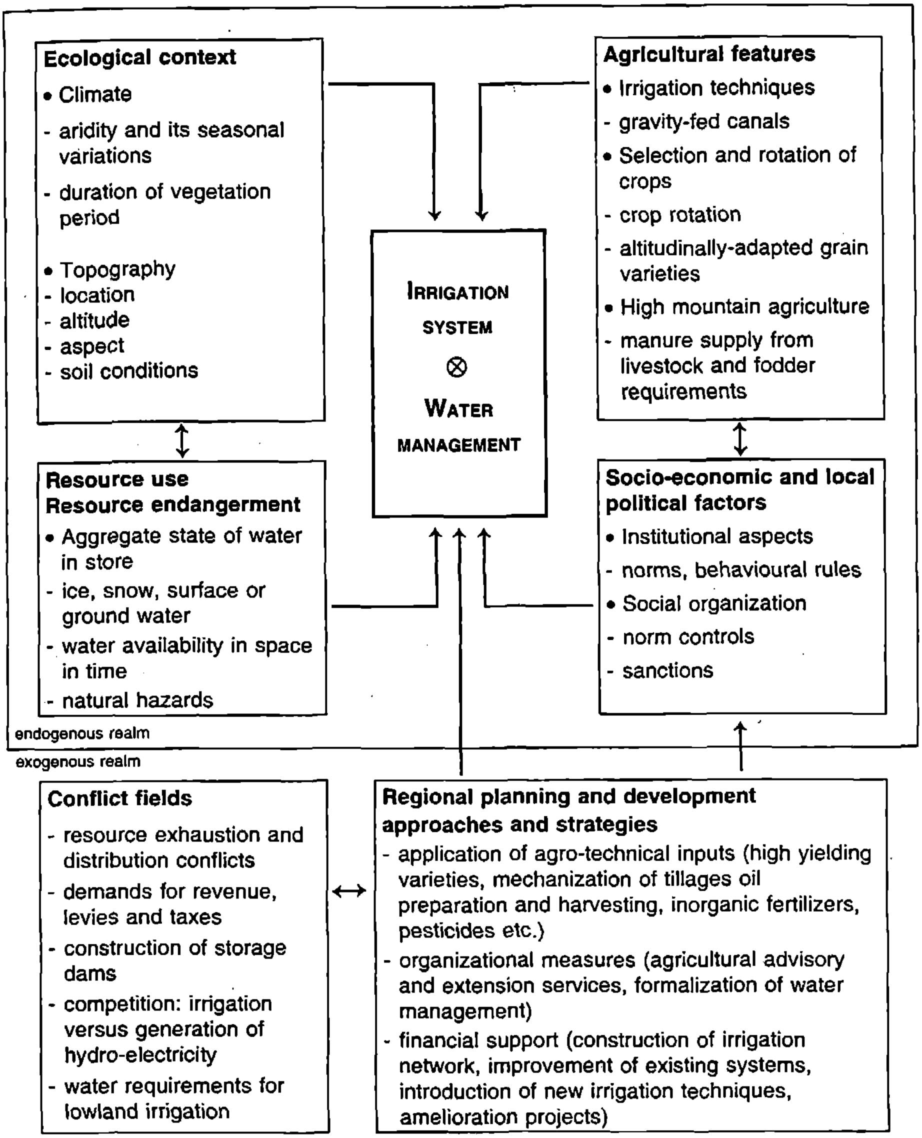
Ecological context
• Climate
- aridity and its seasonal variations
- duration of vegetation period
• Topography
- location
- altitude
- aspect
- soil conditions
Agricultural features
• Irrigation techniques
- gravity-fed canals
• Selection and rotation of crops
- crop rotation
- altitudinally-adapted grain varieties
• High mountain agriculture
- manure supply from livestock and fodder requirements
IRRIGATION SYSTEM ⊗ WATER MANAGEMENT
Resource use
Resource endangerment
• Aggregate state of water in store
- ice, snow, surface or ground water
- water availability in space in time
- natural hazards
Socio-economic and local political factors
• Institutional aspects
- norms, behavioural rules
• Social organization
- norm controls
- sanctions
endogenous realm
exogenous realm
Conflict fields
- resource exhaustion and distribution conflicts
- demands for revenue, levies and taxes
- construction of storage dams
- competition: irrigation versus generation of hydro-electricity
- water requirements for lowland irrigation
Regional planning and development approaches and strategies
- application of agro-technical inputs (high yielding varieties, mechanization of tillages oil preparation and harvesting, inorganic fertilizers, pesticides etc.)
- organizational measures (agricultural advisory and extension services, formalization of water management)
- financial support (construction of irrigation network, improvement of existing systems, introduction of new irrigation techniques, amelioration projects)

Figure 3.2: Schematic diagram of relevant interrelationships in the field of water management in high mountain regions.

affected regions of the south follow a different climatic pattern compared to the overall drier regions lying north of the High Himalayas and the main Karakoram ranges. Seasonal variations in precipitation are features of both regions in regard to quantity and length of their humid periods.

Besides this principal difference in the meridional section, an increase of annual precipitation can be observed from west to east. The overall drier subregions of the Karakoram contrast with the more humid Eastern

Himalayas. The mean annual precipitation recorded at weather stations varies in the western part, from 83 millimetres in Leh to 660 millimetres in Srinagar, while the monsoon-exposed Murree hill station exceeds this pattern with 1514 millimetres on average. Seasonal subcontinental summer precipitation contributes significantly to 1402 millimetres in Kathmandu, falling leeward of the High Himalayan range, to 443 millimetres in the Tibetan capital of Lhasa. Monsoonal impact on climatic regimes is reflected in the high precipitation values in the Eastern Himalayas of Kalimpong (2198 millimetres) and Darjeeling (3220 millimetres), culminating at 10,780 millimetres (maximum recorded value: 24,000 millimetres per annum) in Cherrapunji. To complete the three-dimensional zonal model of mountain ecosystems as suggested by Troll (1967, 1972b, 1975) the hypsometrical progression of precipitation with altitude has to be accounted for in the same manner. The perception of desert oases in the Karakoram settlement regions has to take into account that precipitation values range from below 150 millimetres in the valley bottoms to more than 2000 millimetres in the nival zone.[4]

The specific combination of regional and vertical location, aspect and climatic seasonality is reflected in the vegetation belts and regional geo-ecological differentiation patterns which have been studied by a number of scholars in great detail.[5] The highest elevations are composed of the nival belt which forms the principal area of ice and snow accumulation. These mountain ranges fulfill a dual function: subcontinental division and water storage. They feed the major river systems with a substantial quantity of glacier melt. The ice-cover of the Karakoram varies between 28 and 48 per cent of the surface, while the Himalaya offers a glaciated relief of 8 to 12 per cent of its entire area. This storage which is located mainly above the snow line, in addition to the massive glacier lobes reaching beyond, composes the so-called water towers of high Asia. Several of the major rivers of the world originate from this reservoir (cf. Fig. 3.1) which support the irrigated oases of the rimlands and plains areas north and south of the barrier as *Fremdlingsfluesse* (pirate rivers). They have made the establishment and extension of irrigation possible in lowlands like the *doab* (region between two rivers) of Punjab, in Rajasthan, the Indo-Gangetic plains, the corridor between Kun Lun Shan and Takla Makan Shamo, and the *doab* of Oxus and Jaxartes to name but a few.

This mountain wall separates cultivated stretches and feeds the oases in arid environments by supplying water over long distances through major river systems. Modernization programmes have combined the hydro-energy potential of these mountains with irrigation through the building of a number of major dams (Tab. 3.1), predominantly constructed within the last forty years. The view from outside emphasizes the natural potential of mountain regions for development activities in the lowlands.

Tab. 3.1
Important dams for irrigation and power generation in High Asia

Dam site	River system	Country	Height of dam (m)	Power generation (MW)
Rogun*	Vakhsh	Tajikistan	330	
Nurek	Vakhsh	Tajikistan	335	2700
Sarobi	Kabul	Afghanistan		
Naghlu	Kabul	Afghanistan		
Ambahar*	Kabul/Swat	Pakistan	281	1270
Bazargai	Kabul	Pakistan	293	2000
Munda*	Kabul/Swat	Pakistan		760
Warsak	Kabul	Pakistan	76	546
Khanpur*	Haro	Pakistan	50	
Sanjwal*	Haro	Pakistan	50	2250
Kohala	Jhelum	Pakistan	24	2000
Khaplu*	Shyok	Pakistan		600
Skardu	Indus	Pakistan	94	
Basha*	Indus	Pakistan	98	3360
Dassu*	Indus	Pakistan		2722
Bunji*	Indus	Pakistan		1920
Thakot*	Indus	Pakistan		2415
Tarbela	Indus	Pakistan	142	2500
Dhok Mila*	Indus	Pakistan		1200
Kalabagh*	Indus	Pakistan	79	3600
Mangla	Jhelum	Pakistan	116	1140
Naran*	Kunhar	Pakistan		
Abbasian	Jhelum	Pakistan		
Bhakhra	Sutlej	India	226	1050
Nangal	Sutlej	India		
Pong	Beas	India	133	1200
Parvati	Parvati	India	167	1900
Tehri*	Bhagirathi	India	260	2200
Koteshwar	Bhagirathi	India	104	
Kotlibhel	Bhagirathi	India	210	2000
Utayasu	Alaknanda	India	246	1000
Tanakpur	Sharda (Mahakali)	India/Nepal		
Pancheshwar	Mahakali	Nepal	232	2000
Chisapani	Karnali	Nepal	270	10,800
Barahashetra	Kosi	Nepal	230	3600
Arun III*	Arun	Nepal	68	201
Chukha (*)	Wangchu	Bhutan		336 (*2026)
*	Sunkosh	Bhutan		
Tipaimukh	Barak	India	161	1500

*) Under construction or in planning stage

Source: Ahmed 1989; Bandyopadhyay and Gyawali 1994: 6; Nazir Ahmad and Chaudhry 1988: 4.50–4.83; Central Statistical Office 1987: 38; UNDP 1991: 16.

The Indus Water Treaty of 1960, which established a framework for the division of Himalayan water resources between Pakistan and India, boosted an ambitious programme of dam and link canal construction in the Indus Basin.[6] Irrigation networks in the North-West Frontier Province, Punjab, Sindh, Haryana and Rajasthan profited from this internationally financed programme. Since the early years of rural development, these large-scale projects have formed an integral part of the so-called *Green Revolution*[7] and have depended on the regular allocation of substantial quantities of irrigation water from major storage reservoirs. Their dual purpose of balancing water supply and power generation supported the development philosophy of economic growth-related activities.

The competing requirements for seasonal plant water requirements in agriculture, and the need for a steady supply of electricity to industries and households cannot be balanced in a situation of insufficiency. The policy which emphasizes the primacy of agriculture has led to the subcontinental phenomenon of load-shedding[8], where power generating turbines need to be periodically stopped due to a lack of water to turn them. When cropping sequences in the plains require low water supply—like e.g. during harvest periods—the authorities hold back the water supply and energy users have to share a reduced electricity availability. In order to satisfy the ever increasing demand for electricity, new dams are being planned or are under construction further upstream (cf. Tab. 3.1). Projects like Basha (Pakistan), Tehri (India) and Arun III (Nepal) have attracted the criticisms of environmentalists, as these large-scale projects are located in earthquake-prone areas, generate energy remote from the beneficiaries and involve massive foreign investment and technology which will increase debt of these countries and their dependence on external aid. The life span of major dams has been significantly reduced by siltation processes within the reservoir which severely affect the dam's storage capacity and accelerate the depreciation of investment. The impact of dam construction on regional infrastructure, like resettlement of people, loss of houses and valuable agricultural land within the mountains, and the need to shift transportation routes, are often underestimated in feasibility studies.

Although these large-scale projects continue to be promoted by international consortia and national governments, the lobby for decentralized small-scale projects, both for irrigation and hydro-power generation, has grown in recent years.[9] In this context water has gained in overall importance, becoming the most valuable natural resource of the mountain regions.[10] Increased competition over this resource potential within the mountains is reflected by different approaches towards its utilization and in the escalation of conflict over distribution.

Indigenous irrigation systems within these harsh mountain environments have been long neglected because outsiders felt remote valley societies were backward and had a limited growth potential. Awareness of these systems has substantially grown within the last decade, but accessible information about their cultural and socio-economic foundations is still quite limited. Development agencies implementing integrated rural development programmes have tried to build up what they know about these local technologies in recent years and have begun to emphasize co-operation with farmers in order to serve their felt needs. In sum, there appears to be an increasing demand for complex information about locally adapted irrigation systems and their related societies, to serve as a nucleus around which a new kind of regional development can be developed, involving a shift from big-scale projects to smaller-scale local and decentralized approaches. One has to keep in mind that variety within the mountain habitat forms one of its principal features.

Despite its function as an agglomeration of water towers, the vertical humidity pattern of this mountain arc creates extreme differences between valley bottoms and peak regions. Nominal values of precipitation alone do not define the necessity for irrigation. The relevant equation is based on parameters like absolute value and seasonality of rainfall, temperature regime, regional evapo-transpiration characteristics and plant-specific conditions. Following this approach, the border between arid and humid regions vary significantly from an agronomic viewpoint. The threshold for irrigation (*abi, khet*) requirements is exceeded in mountain regions like the Taghdumbash Pamir, Eastern Hindukush, Karakoram valleys, Ladakh and Zanskar, Dolpo, Mustang and so on, where rainfed (*daymi, lalmi, barani, bari*) cropping fails in the habitated zones. Farmers apply irrigation, beyond that threshold, to safeguard the necessary water supply or to extend the growing season into dry periods.

The majority of contributions in this volume are concerned with these intra-mountainous regions reflecting the diverse patterns of adaptation to harsh environments. The transition zone between arid and humid conditions is a major target area for development projects (Himachal Pradesh, midlands of Nepal). The introduction of supplementary irrigation in these areas can safeguard cultivation and improve cropping patterns. It is principally the scale and outline of mountain irrigation systems that differentiates them from those of the lowlands. Differences in the water management strategies in the study area appear to be related to dissimilarities in environmental conditions. High relief energy allows farmers to construct open irrigation channels which depend solely on gravity flow.

The organization of water management reflects differences in the social structure between highlands and lowlands. The plains of the subcontinent are characterized by a rather unequal distribution of land holdings including landlordism, tenant farming and landlessness.[11] The separation of water and land rights as well as the capitalization of production factors (land, water, seeds, traction and labour) relates to the appearance of a significant social stratification, indebtedness and sharecropping arrangements. The commercialization of agricultural production factors appears to be a characteristic societal feature. This is true not only in communities where *qanat* or *karez* irrigation prevails, such as in Baluchistan, Afghanistan, the fringe oases of the Northern Takla Makan (e.g. Turfan), but also in the huge oases of the piedmont areas, which were transformed during colonial times into the largest compact irrigation network (Punjab, Sindh) of subtropical zones.[12]

Water and land have become key factors in rural power structures. Although every water user was entitled initially to a sufficient supply of irrigation water (*pukka warabandi*), or to an equal share of water per land unit (*kutcha warabandi*), in a closed area, structural deficiencies are prevalent to the present day.[13] Subsequent developments in the allocation of this scarce resource combined with social differentiation processes have contributed to a highly stratified society with many tenants and landless agricultural labourers at the bottom of the social pyramid and a few landlords at the top. Aside from the technical problems of water distribution, the socioeconomic features of centralized control, inadequate water pricing and management of irrigation systems, credit and indebtedness as well as colonial and post-colonial policies have added to this lack of equity in social standing and resource utilization.

In a number of mountain valleys, on the other hand, one can observe village communities and water user associations which are composed of peasants. Basically all village households own land and every small holder is eligible to a quantity of irrigation water equal to the size of his holding. Traditionally, the commercialization of water is prohibited among villagers; and although a few cases of this practice[14] have been observed in recent times, the general pattern of prohibition holds true for most of the Karakoram and the inner Himalayan valleys where a combination of individual and communal ownership of natural resources structure property rights.

A somewhat different situation has occurred in Tajikistan, Xinjiang and Tibet (Xizang), where collectivization programmes in the aftermath of respective revolutions resulted in a radical transfer of private land holdings into public property, and the communal organization of agricultural work. Recent deregulation has not abridged this pattern in principle. The case studies presented in this volume will elaborate on the inter-relationship of socio-economic conditions, transformation processes and water management practices thus revealing the differentiation between and the variations within mountain societies.

Tab. 3.2

Areawise differentiation, population figures and growth within subregions of the mountain belt

Region	Area (km^2)	Population 1901	Population 1951	Population 1981	Rate[a] 1901–1951	Rate[b] 1951–1981	Inhab/ km^2 1901	Inhab/ km^2 1981
Kashmir-Himalaya	222,797	2,139,362	3,253,852	5,981,600	0.8	2.1	9.60	26.85
Punjab-Himalaya	55,500	1,920,294	2,385,981	4,237,569	0.4	1.9	34.60	76.35
Kumaon-U.P.-Himalaya	51,100	1,207,030	3,106,356	4,815,326	1.6	2.2	23.62	94.23
Nepal-Himalaya	142,124	5,638,749	8,473,478	15,020,451	0.9	2.1	39.67	105.68
Sikkim-Himalaya	7100	30,458	137,725	315,682	2.5	2.8	4.29	44.46
Darjeeling-Himalaya	3200	249,117	624,879	1,006,434	1.8	1.6	77.85	314.51
Bhutan-Himalaya	46,500	—	—	1,162,000[c]	—	—	—	24.98[c]
East. Himalaya (Arunachal)	83,700	—	336,558	628,050	—	3.2	—	7.50
Himalaya (total area)	612,021	11,185,010	18,318,829	33,167,112	1.0	2.0	18.27	54.19
Karakoram	51,776	94,731	215,445	451,853	1.6	2.5	1.82	8.72
Eastern Hindukush	14,850	48,740	104,648	208,560	1.5	2.3	3.28	14.04
Chinese Pamir	4275	4891	10,238	20,153	1.7	2.3	1.14	4.71
Badakhshan Pamir	64,000	20,000	45,000	127,709	1.5	4.6	0.31	2.00

Rate[a]: mean annual population growth rate between 1901 and 1951 (in %).

Rate[b]: mean annual population growth rate between 1951 and 1981 (in %).

[c] Population data for Bhutan have been reduced significantly by official sources in 1991 which identify a population of 0.6 million (UNDP 1991: 10) equivalent to a population density of 12.9 inhabitants per square kilometre.

Notes: Badakhshan Pamir (Gorno-Badakhshan in present-day Tajikistan: data for 1897, 1953, 1979 respectively); Chinese Pamir (Sarikol/Tashkurgan District: data for 1910, 1953, 1982 respectively); Eastern Hindukush (data for Chitral District); Karakoram (data for Baltistan and Gilgit District); Kumaon (column 1951: data from 1961); Nepal (column 1901: data from 1911; column 1951: data from 1952–54); Sikkim (column 1901: data from 1891); Eastern Himalaya (column 1951: data from 1961).

Source: compiled from Kreutzmann (1993: 46; 1996: 169, 209–215, 268)

Adaptation to harsh environments and communal enterprises in construction, maintenance and management of hydraulic systems have to be evaluated with reference to the population dynamics of the area (Tab. 3.2), which again differentiates it from plains societies. The comparatively low man-land ratio in the mountainous areas disguises the actual pressure on quite limited cultivable resources. Population densities vary quite dramatically within the mountain arc; depending on settlement history, resource potential and exchange relations. Overall population growth, which in most regions ranges falls below the national average of their respective countries, requires special arrangements to satisfy a progressing demand for work and nutrition. In this context, one has to emphasize the impact of institutional intervention. Governmental and non-governmental organizations have played a role with the implementation of increasing number of development projects in mountain areas. One of these approaches, the physical construction of irrigation channels, targets the extension of irrigated cropland, on the improvement of marginal areas and on the shift from monsoon-dependent agriculture to irrigation farming in transition zones (Tab. 3.3).

Tab. 3.3
Increase in irrigated land area in concerned countries between 1970 and 1990

Country	irrigated land (in thousands of hectares)			increase of irrigated land
	1970	1980	1990	1970–1990(%)
Afghanistan		2600[a)]		
Bangladesh	1058	1569	2936	177
Bhutan		30[b)]		
China	37,630	44,888	47,403	26
India	30,440	38,478	45,500	49
Kazakhstan	1451	1961	2300	59
Kyrgyztan	883	955	1030	17
Nepal	117	520	1000	754
Pakistan	12,950	14,680	16,960	31
Tadschikistan	518	617	690	33
Turkmenistan	643	927	1240	93
Uzbekistan	2696	3476	4159	54

a) data only available for 1978 (Grötzbach 1990: 102)

b) data only available for 1984 (Central Statistical Office Planning Commission Bhutan 1987: 24)

Source: data compiled from Létolle and Mainguet 1996: 218; World Bank 1994: 143–145

The well-established practices of the *Green Revolution* have been applied on a smaller scale in mountain area watershed management programmes[15] aimed at enhancing the productivity of existing oases through the introduction of mechanization, high yield varieties and new crops, fertilizers and pesticides. Besides supporting local communities through material aid and expertise in agricultural extension and marketing, project interventions also effect irrigation management practices. A key feature in some of the case studies and strategy papers by development practitioners is how these projects contribute to sustainable and equitable growth.

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NOTES

1. Mountain Agenda (1992: 4). This document was prepared for the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, June 1992. For the follow-up conference in New York (= Rio+5) Bruno Messerli and Jack Ives (1997) edited a volume in which the water towers featured prominently again, cf. Kreutzmann 1998b.
2. This scenario can be observed in the process of outlining the *National Irrigation Policy* of Bhutan (Royal Government of Bhutan 1991: i), in reports on Nepal (Adhikari 1987, Martens 1989, Pradhan 1989a, b) as well as in the implementation of irrigation-related development packages in Northern Pakistan (Saunders 1983: 44–48; 1984; Whiteman 1985a: 37–40; 1985b).
3. See the bibliographical references at the end of each contribution and some studies which recorded local knowledge like Allan 1986; Aubriot 1991; Bentum, Namgyal and Smout 1989; Charles 1985; Coward 1990; Fautz 1963; Hunt and Hunt 1974; Israr-ud-din 1992; Kreutzmann 1988, 1990; Linkenbach 1994; Nagel 1973; Nitz 1966, 1971; Patzelt and de Grancy 1978; Smout, Bentum and Namgyal 1992; Staley 1982; Yoder, Martin, Barker and Steenhuis 1987.
4. Two recent studies have enhanced the knowledge on hypsometrical and regional variations in climatic conditions in the western part of the area under study; cf. Reimers 1992; Weiers 1995.
5. Cf. the classical synopsis of the Himalayan vegetation cover by Schweinfurth 1957 which forms the starting point for later case studies like e.g. Dobremez 1976; Haffner 1979; Miehe 1982, 1990, 1991; Schickhoff 1993. For the Hindukush, Karakoram and Pamir cf. Haserodt 1989; Paffen, Pillewizer and Schneider 1956; Agachanjanc and Lopatin 1978 respectively.
6. Cf. for the effects of this bilateral accord on Himalayan water resources which was negotiated under the auspices of international bodies Michel 1967; Nazir Ahmad and Chaudhry 1988; Scholz 1985. A description of the Rajasthan canal project being a result of this treaty has been presented by Bhattacharya 1976; Gardiner 1987.
7. The effects of the *Green Revolution* have been widely analyzed and were the subject of controversial discussions, cf. for a summary Bayliss-Smith and Wanmali 1986; Farmer 1986, Glaeser 1987.
8. Load-shedding occurs in situations of sole dependence on hydro-power. Seasonal variations of water-flow (with minimum discharge in winter and spring) cause reduced supply for power generation. The problem of load-shedding is aggravated by the above-mentioned competition between irrigation demands and power generation schedules. Regular periods for load-shedding are December-January and April-June, cf. Kreutzmann 1998a.
9. The approach of the Small-Hydel Development Organization (SHYDO) which operates as Pak-German technical cooperation project sponsored by GTZ within the Water and

Power Development Authority (WAPDA) seems to be more appropriate for the needs of people living in the mountain regions and less prone to natural hazards than the multi-billion dollar plans of constructing seven major dams along the Indus (six above the existing Tarbela dam; cf. Tab. 3.1) which are favoured by international consortia and the Pakistan Government. Similar blue-prints originating from Soviet times exist along the Vakhsh river of Tajikistan.

10. For a general discussion on the politics of scarcity in a wider context cf. Lowi 1993; Roy 1990; Starr and Stoll 1988.
11. Cf. for a brief introduction into agro-social structures in the subcontinent Akmal Hussain 1989; Byres 1989; Fuller 1989.
12. The impact of share-cropping on rural societies and the variety of irrigation systems of the plains areas has been covered by numerous studies especially in the Middle East and Central Asia; cf. Balland 1992, 1993; Beaumont, Bonine and McLachlan 1989; Ehlers 1983, 1985; English 1968; Goblot 1979; Golomb 1951; Hartl 1979; Hunt and Hunt 1976; Jentsch 1970; Manig and Kuhnen 1986; Mann 1992; Rahman 1981; Scholz 1978; Starr and Stoll 1988.
13. Tail-enders are the losers especially in the *kutcha warabandi* system compared to the top-enders; cf. Nazir Ahmad and Chaudry 1988.
14. See the report by Aase (1992) who describes such recent practices from the Western Himalayas.
15. A decade ago a first survey of development programmes following a participatory approach was presented by Dani and Campbell (1986).

4

Some Notes on the Contribution of the Study of Irrigation to the History of Central Asia

Vincent Fourniau

INTRODUCTION

Compared to the surrounding great empires, Central Asia has always remained understudied. These few notes on irrigation present a good opportunity to illustrate the overall unique qualities of this area and the importance of its study.

Although not a native representation, the expression "Central Asia" was advanced during the course of the submission of the area to its surrounding empires. Toward Persia and Afghanistan in the west, the limits of the Tsarist and later the Soviet states echoed, in part, a traditional political balance whose evolution was stopped by the colonial conquests of the years 1850–90. Through this heritage, the frontiers of the area's post-Soviet states maintain some links with the pre-colonial political configurations.

I shall focus on the traditional political space that coincide with some of these states, particularly those located in Transoxiana (the area beyond the Oxus, or Amu Daryâ), such as Uzbekistan and Tajikistan, and the immediate neighbouring areas of Southern Kazakhstan, Western Kirghizstan, and Eastern Turkmenistan, which also belong to the drainage area of the Aralo-Caspian basin.

The Mongol conquests of the period 1215–60 had such tremendous political, economic and institutional consequences that it became common among scholars to use the expressions pre-Mongol or post-Mongol to establish a chronological separation in the history of these countries. The post-Mongol period will serve as a framework for these pages.

The mountainous area of the Aralo-Caspian zone (Fig. 4.1) is more humid than the lowlands, except for some deserts at high altitude, but it is also

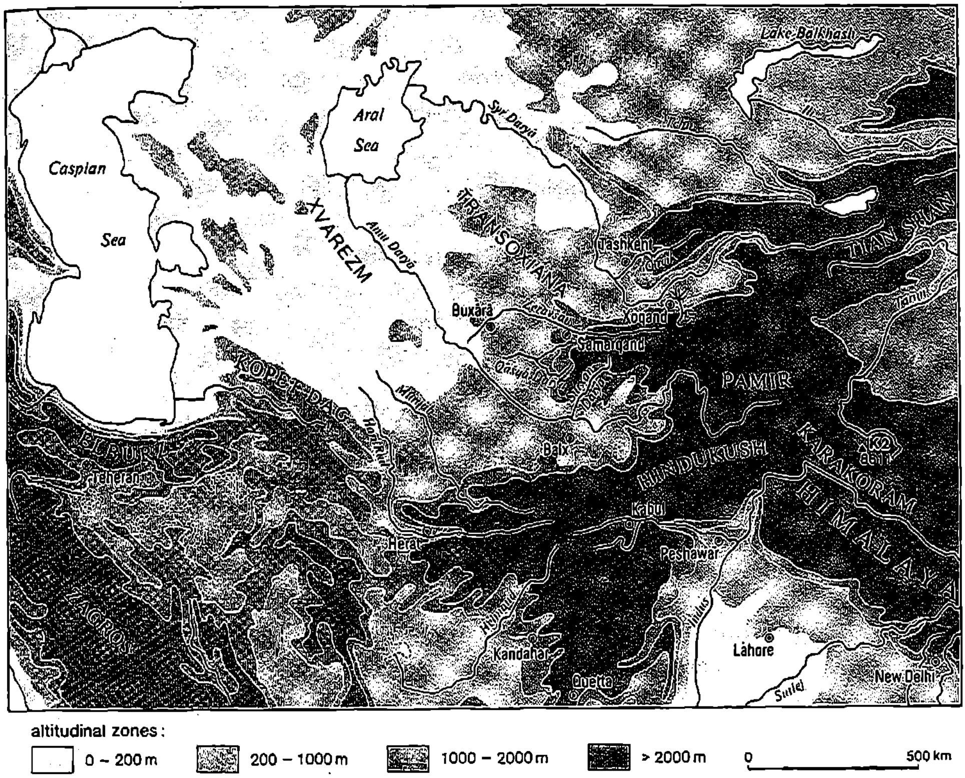

Figure 4.1: Map of Central Asia.

marked by drastically lower temperatures so that the highlands of Central Asia have only sparse pluvial agriculture. The lowlands are the areas best suited for agriculture, despite their low rainfall, and in southern Central Asia, sedentary life is best defined by one's proximity to a river for water diversion. Among all forms of irrigation in use in Central Asia, the diversion of flowing water, or rivers, into an artificial network of canals is by far the predominant form of irrigation for agriculture. It is also the most diversified one.[1] Indeed, water may be diverted both from large rivers as well as from small non-perennial brooks; and even from tanks collecting rainfall.[2] One finds canals in the mountains as well as in the plains; both in regions receiving some 500 millimetres of yearly precipitation, as well as in fully arid steppes crossed by a 50-millimetre isohyet.[3] The diversion by natural stream, complemented by water lifting devices, if necessary, is indeed the primary means for practising intensive agriculture in the portion of the arid zone, which includes southern Central Asia.[4]

Besides a diverse physical geography, one also finds great diversity in the communities using artificial irrigation: from exclusively sedentary agriculturists to small groups of nomads utilizing a few *âriq*[5] carved out in the steppe for occasional agriculture. Exclusively sedentary agricultural communities may be found commanding large irrigation systems as well as small isolated systems, using irrigation in conditions of extreme drought as well as in quite humid foothills. A comparable variety characterizes the agro-pastoral communities utilizing water for irrigation purposes.

Artificial irrigation, by definition, permits sedentary life in a dry to very dry milieu, where the ecological niche for pluvial agriculture, if any is very narrow. Only the mountains of Central Asia are sufficiently well provided with precipitation, but they present greater obstacles to agriculture than flat dry lowland areas, criss-crossed by rivers.[6] The very variety of irrigation types and practices reveals the responses developed by Central Asian communities to adapt to their environment. Taken alone, however, and even if viewed through its technological evolution, this variety does not represent the entire scope of social situations associated with irrigation in Central Asian history. One may say that there is a conflict between technological development of the area, and the migration history and pace of population growth. This apparent conflict makes the post-Mongol era appear as a long period of permanency. This is particularly striking in the domains of production and agricultural equipment, given the intensity of the historical events that took place from the thirteen to the nineteenth centuries.

The study of constraints created by water shortages and the management of such situations provides an insight into the most varied aspects of the societies, which use irrigation. Better collaboration among those who study the various aspects of irrigation and the integration of their results would certainly help to produce new historical perspectives on Central Asia.

River Regimes and Their Environment

The spates of the rivers of Central Asia (Amu Daryâ, Zeravšân, Syr Daryâ, Sox etc.) have the particularity of occurring during the warm season, which coincides with the dry season. The spates are the result of melting of snows and glaciers in the very high mountains surrounding Transoxiana on its southern and eastern perimeters. The continental climate also plays a role in sharply opposing cold and warm seasons, for during the latter, the melting continues until the middle of summer. As a result, the level of the rivers only increases during the growing season. Many of the cultivated species ripen even before the rivers run low, beginning in autumn.

The greater the proportion of glacier melts in the river cycle, the later the spate will occur, even until mid-summer. Eighty per cent of the total runoff of the Zeravšân flows from May to September. The yearly cycle of this river is largely dependent on this melting, as it is with Amu Daryâ, the Sox and many other rivers in the region. The last high water mark, which occurs in July, is the most important one. On the other hand, the most abundant high water mark lies between April and June for rivers having a predominantly snow melt-based cycle, like the Murqâb and the Surxân Daryâ. There are several peak periods during the high water months. The spates fertilize and warp due to rivers' charge of solid materials; several millions tons of such materials are deposited every year. This fertilizing function is very important for the fields, in a region where very little manure is available.[7]

The Amu Daryâ River has a six-month high water period, between March and September, during which there are four peaks of the spate.[8] Each peak will culminate in ten to fifteen days.

The high waters of the Syr Daryâ were studied less thoroughly in the pre-Soviet period than the spates of the Amu Daryâ or of the Zeravšân. The fact that the sedentary population has decreased in this valley since the Middle Ages may explain the lack of attention given to them. Indeed, the oases of the Syr Daryâ basin are smaller than those located in Transoxiana, except for Taškent, and the rare cities of this region which had a political role in the post-Mongol era (as Sygnak, Sauran, Isfidjâb), were mostly located in the so-called "nomadic states", as opposed to those of Transoxiana. The middle and the lower portions of the valley are also the sites of the vestiges of many ancient cities (as Yangikent, Jend and others). These regions offer a wide range of semi-nomadism.[9]

The spates of the Zeravšân possess four peaks, like the spates of the Amu Daryâ.[10] The most intense social mobilization revolving around irrigation in Transoxiana takes place in the Zeravšân valley. This is due to the importance and the density of the oases located in this region, the very axis of sedentary life in Transoxiana.

Arid plains of Central Asia are among the poorest regions in the world in terms of plant variety in the natural vegetation.[11] There is also a lack of diversity among cultivated species in southern Central Asia, in the lowland rural communities as well as in the villages in the mountains, but the latitude and the altitude remain crucial factors in the agricultural life.

THE MAIN TYPES OF IRRIGATION

Whatever the internal dynamics of the history of pre-industrial irrigation technology may have been, from the Bronze Age until the European colonization of the nineteenth century, the post-Mongol period proves to be a living conservatory of this evolution. Numerous types of water distribution characteristic of one period or another were, or are still, in use in both medieval and modern irrigation. Their study is therefore of great interest for ethnologists, archaeologists and historians. The many variations, which exist in post-Mongol irrigation, can be explained through differences in the environments where they developed, whether or not this milieu was devoted exclusively to sedentary agriculture.

1) Irrigation by diversion

Irrigation by diversion uses the natural current and the slope of the terrain. This gravity-fed irrigation canal is the most common type found in Central Asia. It is characterized by a diversion dam on the river and a diversion canal. The connection of the diversion canal with other canals produces a hierarchical system, from the banks of the river to the cultivated fields. An example of such a hierarchical system is the Xvârezm region, on the lower stream of the Amu Daryâ River.[12] This is a very arid region, where there is no other water supply for agriculture except from the Amu Daryâ, which flows into a large, flat valley along this portion of the stream.

Peasants of Central Asia carve out the inlets (*saqâ*) of a riverbank taking the force of the stream in floodwater season into account, as well as the instability of the banks of the Amu Daryâ. The headworks are small in the Xvârezm region, in order to avoid erosion by the stream and several of these small headworks may be necessary to ensure a regular supply of water to the irrigation systems. When there are several of them, they are several kilometres apart, and the inlets are placed at different heights on the banks of the river. This ensures a regular filling of the irrigation networks. During the off-peak season, water flows into the irrigation canals through the lower inlet, while during the peak period of the spate, it flows also into the upper: both inlets therefore have a complementary function.

The main, secondary and tertiary canals of the Xvârezm region are large but not deep. The main canals are called *ârnâ*. The first meaning of this word is “portion of a river”, “channel separated from the main stream by sand-bank or by an island”. By analogy, *ârnâ* is also used to designate the main canal. This word, derived from the ancient language of Xvârezm, has been integrated into the Turkmen and Uzbek languages. The term *yâb*, which designates the small canals, also originates from the ancient Iranian language of the region.[13] In the other regions of Central Asia, reference sources commonly use the term *âriq* or *juybâr*, and more rarely the terms *nahr* or *šurakoy* for canals.[14]

Generally, the canals are larger upstream than downstream, and in the post-Mongol period they are larger than in ancient times. The profile of some of the ten largest canals of Xvârezm (on the left bank) in the mid-nineteenth century is as follows.[15] Šâh Abât (which is the longest), length: 135 *versta*[16], width: 14 *sažen*[17]; Yarmis, length: 95 *versta*, width: 8 *sažen*;

Polvan Ata, length: 90 *versta*, width: 25 *sažen* ; Xoni (the shortest), length: 20 *versta*, width: 2.5 *sažen.*

The number of secondary canals is highly variable, as shown by the following examples[18]: the Polvân Atâ has twenty-one secondary canals on the left bank, measuring 6, 5 to 18 *versta* in length each; only four secondary canals are located on the right bank, with lengths ranging from ten to thirty-six *versta*. Some of the big canals like the Yârmiš have almost no secondary canals. Others, like the Suvâlli, have such an abundance of secondary canals that some of them have not even been named. Most of the large canals of Xvârezm drain into lakes of stagnant water, like the Arnâ, which reaches the Porsu Lake.[19] This contributes to the presence of useless water, so abundant for such a dry region.

In the Xiva region, field channels or furrows are called *târtmâ*. A sixteenth century *vaqf nâme* establishing the *vaqf* donation of the properties of the princess Mehr Soltan Xânom in Samarqand uses the term *kutârmâ* to designate them.[20]

Drainage channels or colature canals, the parallel system used to drain water from the system, are not very common among the traditional technologies of Central Asia, except in some micro-environmental situations. The discharge of used and surplus water is important, especially the latter, which may deteriorate some of the small structures within irrigation systems, such as small dikes and hydraulic gates. Since neither the time of watering, nor the yearly cycles of the rivers are entirely predictable, there might be surplus water at certain times of the year, even in the oases known for their chronic lack of water. This is particularly true where filtration or settling is not used.

The filtration technique is linked to the drainage systems in this sense that only a sloping terrain can allow it. One does not find them in the completely flat regions like Xvârezm or the lower Zeravšân. However, further upstream on the Zeravšân, in the region of Samarqand and beyond, watering from one level of parcels to another is made possible due to widely used filtration.[21]

Lifting devices are used throughout Central Asia at every point of the irrigation system where the rivers' flow is too weak or the slope gradient too flat to allow a full and convenient command of all portions of a system. Two major types of lift apparatus exist: man-powered or animal-powered apparatuses, and water-powered devices (*čigir*).[22] The man-powered water lifting devices are scoops (*sepma* and *nova*), or the mobile buckets, (*depma*, as they are called in Xvârezm). The animal-powered or water-powered devices are wheels with troughs (*čigir*).

Generally principles of irrigation by diversion are essentially aimed at regularizing and controlling the flow of the rivers. When it is necessary to carry the water to spots where the river cannot flow by itself, the *čigir* is the crucial device, but regulation is also necessary to tame the rush of the rivers' flow and to avoid destruction within the irrigation system. Regulating structures are placed within the irrigation system at the intersection between large or small canals to prevent water from entering into unwanted areas or to diminish its discharge. Such structures are a necessary part of distributing water to a field. These structures consist of small, often temporary dikes, destroyed when watering. In the Xvârezm region, such small dikes are called *doldarga* and the sluice gates, *saxaul*. They are very fragile structures as they are fashioned with highly washable, often sedimentary, local soil. Sometimes devices, like the *torkutkâ*, are placed in the system. The *torkutkâ* is a wood cylinder from fifty centimetres to two metres in length, and from five centimetres to thirty centimetres in diameter placed at the intersection of secondary canals (*yâb*).

Dams are used in water control in most of the oases throughout the south central region. Such dams are called *band*.[23] These dams are built out of wood and earth and must be repaired each year. Technologically speaking, these dams are a discrete and fragile element of the irrigation system. The wider across the river, the greater will be the amount of water diverted into irrigation canals. A dam is constructed on the bank opposite the mouth of the main canal, which forces the water into the mouth of the large canal.

Fascines, or large cylindrical bundles of well-agglomerated branches and reeds, are common in most of the irrigation regions of Central Asia. The bundles of branches are also loaded with earth and fine gravel, and reinforced by lateral beams. Their dimensions may vary widely, from one metre to two metres in diameter and six metres to eight metres in length, depending on the size of the canal to be blocked.[24] The same techniques are used everywhere in the area to make these fascines. They are known under a variety of terms: *navâle* in the Zeravšân valley; *navardi* or *vardi* in Xvârezm; *uliki* in the Ferqanah valley; and *qarâburi* in the Middle Syr Daryâ valley including its tributaries, particularly in the Taškent area.

Some ruins of stone constructions have also been found. These dams obstructed the entire width of a canal and have storage tanks associated with them. The ruins of these dams date from a variety of periods, but most of them are concentrated in the Zeravšân basin and in the surrounding regions. One of the most commonly cited structures is Abd Ullah Xân-e Bandi, also called Xân-e Bandi.[25] These dams have attracted the interest of observers, and their scarcity remains yet unexplained. Does this sort of dam represent the climax of a technology, which, even at its peak, remained rare in Transoxiana? Does their evolution before and after the Mongol invasions reflect a certain loss of technological knowledge in Transoxiana? In fact, because of the questions they elicit, they should not necessarily be considered in terms of a technological apex and decline, as this type of dam is not necessarily found everywhere. On the contrary, its utilization is a response to specific conditions of local superficial runoff.

Other solid constructions, built of brick and mortar are known in Transoxiana, particularly culverts and "distributing bridges". These date from both the pre-Mongol and the post-Mongol periods, but remained uncommon during each period. Questions about the existence of these structures and their evolution too have not yet been settled and such discussion must take into account that their utilization would depend on topographical and hydrographical parameters, particularly a very diffused surface runoff, gathered together by this means. Indeed, the utilization of such constructions in Transoxiana has been verified in arid and steep regions.[26]

When the Russians conquered this part of Central Asia (in the 1860s) and made the first archaeological excavations, they made the striking discovery of the ruins of an old "distribution bridge" on the Zeravšân, eight kilometres to the north-east of Samarqand. These ruins are known under several names: Puli Šâdman Mâlik, Abd Ullah Xân or Šaybâni Xân. The bridge permitted the Zeravšân river to be crossed, but it owes its name of "distributing" to several of its other functions: helping the separation of the river into two branches, the Aq Daryâ and the Qarâ Daryâ, by preventing the Qara Darya from flowing into the Aq Daryâ, measuring the repartition of the water for irrigation distribution, and also taming the river.

The number of arches probably changed throughout time, since the bridge has been repaired several times, but its exact configuration when it was used as a distributing bridge is uncertain. Recently, a sole arch was still erect.[27] The earthquake of 1898 destroyed the other arch that was still standing, and one knows that *circa* 1840, there were still three arches. A recent study estimated a total of seven arches for the bridge, but some hypotheses have put forth far more important numbers: sixteen arches according to A. Xoroškin, eight or ten according to Ščušev.

Through the variety of the above-mentioned examples, one may note that a linguistic substratum from the time of the predominance of the Iranian languages in Transoxiana has well survived in the technological domain of a region which became a Turkic speaking area, or more specifically an Uzbek-speaking milieu. This lexical example underlines the relevance of immutable constituents which structure the history of irrigation. The numerous Iranian elements point out the technological continuity which is seen in history of irrigation, and the Turkic layer results from the adoption of new technologies by formerly pastoral, nomadic or semi-nomadic populations when they arrived in Transoxiana and Xvârezm. While appropriating new technologies and new modes of life, they largely transformed the ethno-linguistic profile of the populations of sedentary agriculturists in southern Central Asia.

2) Irrigation from springs

The section, which follows presents various types of irrigation characterized by small or less regular mass runoff, with less water, distributed than in any of the valley systems discussed so far. It is called *bulačnoe orošenie* ("irrigation from spring") from the Uzbek *bulâq*, for "spring", in the existing literature, predominantly in Russian. Irrigation from the springs is found in a few places in the mountainous zones, mostly located in eastern Transoxiana. This is an extreme type of artificial irrigation.

3) Natural irrigation

Two types of natural irrigation have been noted in the area. The first type is called *liman* or recession irrigation. *Liman* is a dialectal word from southern Russia, which designates small depressions, generally circular, that are common in these regions. Applied to Central Asia, the expression "*liman* agriculture" specifies humid depressions used to sow cereals. In spring, these *liman* are filled with water and used as tanks, until they dry. After this, they are used for grazing animals. Because it needs a certain accumulation of snow (unlikely in most of the lowlands of southern Central Asia), as well as a significant warm season for the crops to ripen, "*liman* agriculture" is to be found in many of the highlands of the region.

The second type or *kair* irrigation takes advantage of flooding from lakes or rivers in cultivating the terrain flooded by the spates. In Xvârezm, the non-saline terrain located in the submersible zone of the river terraces is called *kair*. The word *kair* was borrowed to designate this type of irrigation, after being noted in several archaeological expeditions, and by extension, has come to denote all kinds of natural irrigation which take advantage of the overflow of lakes, rivers or marshes.

IRRIGATION AND THE STRUCTURE OF HISTORICAL SPACE

A comparison between natural irrigation and artificial irrigation, including the various devices for diversion, elevation and distribution, is magnificently illustrated by the social implications of two types of irrigation on two main user groups: nomads and sedentary populations. Water resources and the technical improvements to exploit them had a strong effect in the development of lifestyles as diverse as irrigated agriculture and pastoral nomadism, particularly in the post-Mongol period. Nomadic and sedentary communities may alternatively experience prosperity and decline; but in the long run there isn't necessarily a relation between their micro-regional destinies and the overall movements that influence them.

As previously mentioned, diversion canals are found at various altitudes in all of the regions studied, from the lowlands to the foothills and mountain valleys. Only a difference in scale separates the two groups of canals, the large complex systems and the small, isolated systems; both similar in principle but different in their implications on local settlement history.

Both the large complex and small isolated systems each reflect a large number of factors, natural as well as human, which effect the economic diversity of the nomadic as well as the sedentary communities living in Transoxiana. The large complex systems are without a doubt linked to the sedentary type of settlement. They constitute the very core of agricultural and urban development of Central Asia. The capital cities of the post-Mongol period, Samarqand and Buxârâ on the lower Zeravšân river, Xoqand in the Sox basin, Xiva and the Xvârezm region on the lower Amu Daryâ, all depend on such types of systems (cf. Fig. 3.1 of the previous chapter in this volume). There are dozens of big oases throughout Transoxiana, the middle Syr Daryâ, in the middle and upper Amu Daryâ, in the Zeravšân, in the lower Murqâb. These oases are provided with water by hundreds, even thousands of main canals which structure the cultivated space in southern Central Asia. Below are several examples:

(1) The Sox Basin: In the Sox basin, up to the beginning of the eighteenth century, the first city of the Ferqânah valley was Andijân, in the basin of the Syr Daryâ. Indeed, in 669/1270 the Ogodeid khan Qaydu chose Andijân for the new capital city of the Ferqânah valley in the basin of the Qara Daryâ (the name for one of the upper branches of the Syr Daryâ, it is different from the other Qara Daryâ previously mentioned). In the beginning of the eighteenth century, Xoqand replaced Andijân as the first city of the area, before later becoming the capital of the new state which was to be called the Xoqand khanate. Xoqand is located on the detrital cone of the Sox River. The Andijân Say, one of the most important canals of the Ferqânah valley, was built in the second half of the nineteenth century on the Qara Daryâ.[28] The Yângi Ariq was carved out of the Naryn in 1819 (another main upper branch of the Syr Daryâ), and its length is about 100 kilometres.[29] These structures were commissioned by the khans to improve water distribution in the Andijân region for the former, and in the region of Namangân for the latter. Their construction dates from the movement of regional reconfiguration which took place in the last century, and which appears to be the brightest period of the history of the region, according to existing research.

The diversion system created on the Sox was quickly improved and ultimately comprised five main canals. The runoff of the Sox is entirely absorbed by these five systems. One of the five main canals, the Sâri Qurqân, possesses many secondary canals, from upstream to downstream: Mirovât, Qarâultepa, Koštegirmân, Samarqand, Ulyât, Xvâje, Dašt, Kenegas, Bačkir, Buvâydâ, Žigit, Amravât, Islâm, Suv, Pastkuruk, Aq Masjid, Bâzârbâši, Yâypân, Žust, Oxta, Alâtây, Katta Yangi and Jânâbâd.[30] This profusion of diversions of mid-sized rivers illustrates the broad effect of irrigation efforts on much of the Central Asian landscape.

(2) The Zeravšân basin: The Zeravšân basin has an elongated shape, totally different from the Sox basin. This is due to the configuration of the mountains, which delimit the area of the runoff. The irrigation systems of the two areas are differentiated from each other in several other ways. Indeed, the Zeravšân basin has the longest axis of irrigation of any in Transoxiana. After the confluence with the Fârâb, upstream above Penjikent, the Zeravšân River has no tributaries. However, by the end of the nineteenth century, as many as 127 main canals were diverted from it: eighty-three main canals along the 188 kilometres which run from Penjikent to the Russo-Buxaran border of 1873, and forty-three downstream. The following examples show the size of some of these canals: Nahr pay (thirty-four kilometres in length; discharge, 33.04 m^3/sec); Šabât (thirty kilometres in length; discharge, 38.87 m^3/sec); Tas (fifty-three kilometres in length; 8.5 metre width; discharge, 7.76 m^3/sec).[31] The total length of the forty-three canals located within the protectorate of Buxara is 1022 kilometres; their average discharge is 268 m^3/sec; they have 939 secondary diversions.

(3) The Amu Daryâ basin: Since ancient times, the lower regions of the Amu Daryâ basin have been inhabited by an agricultural and sedentary population. By the middle of the nineteenth century, the Xvârezm region was provided with water by means of ten main canals, which had more than one hundred secondary diversions.

The social life produced by irrigation reflects the commitments that rural communities make to pre-agricultural and agricultural labour. This is true for all artificial irrigation in Transoxiana. If there was a difference in the size of the networks between irrigation systems, one may say that in case of diversion of very little size or totally independent hydrographically speaking, infra-agricultural constraints are slightly attenuated.

Irrigation by semi-nomadic populations has mostly developed on a small scale, where overall constraint is diminished because of the simplification of the systems and of their management. It does not seem that there is any example of large canals, such as those derived from the Zeravšân or from the Sox, which are run by predominantly semi-nomadic communities or with a strong nomadic component. And when agro-pastoral communities create new systems of irrigation, they are most likely small-scale systems.

Concerning irrigation by diversion, the question one might ask is whether there is a type of canal or a complexity that could not be managed by agro-pastoral communities and would necessarily create sedentarity groups. This is a very relevant question for the historian, for one must remain open to the possibility of such technological limitations, which might, in turn create such constraints. The presence of large-scale irrigation provides us direct information about its users, called by the umbrella term "sedentary", but only for these periods during which the systems were fully operational. It becomes a very complex but useful tool with which to explore post-Mongol written and archaeological sources concerning the history of settlements, a study not easily nor readily achieved. Indeed, the large complex irrigation systems of lower Central Asia are subject to various constraints in space and time. Consequently, the study of their development is a particularly relevant field to learn the attitudes of sedentary or nomadic populations toward irrigation.

Despite the ancient entrenchment of irrigation technologies in Mâ Warâ al-Nahr, there are many reasons why the large canals were not used for centuries: erosion of the traces, the salinization of the soil and other technological reasons, in addition to the political history of Mâ Warâ al-Nahr.

There exists a quantity of small-scale irrigation practised in the remnants or in the command area of larger older systems. These are largely transitory situations, which may last a very long time and be caused by a variety of reasons, too disparate to convey any relevant information on the evolution (prosperity or decline) of a region when this type of irrigation was in use.

There is much evidence to support the idea that the regional history evolved through successive phases, echoing its very dense political history. In the valley of the Qašqa Daryâ, for example, in two thousands years the political capitals successively occupied four sites located not far from each other. Another significant example is the evolution of the "urban basin" provided with water by the river Balxâb, in southern Bactriana. This region of south Bactriana witnessed the decline of Balx, and the flourishing of the nearby city of Mazâr-e Šarif. From the point of view of the history of water utilization, this case may certainly be viewed as an example of continuity, since the two cities divert their water from the same river, whereas this continuity occurred within a context of crisis of one urban centre in favour of another urban centre.[32] Consequently, agricultural life in the long run tends to consist of the conquest or re-conquest of agricultural lands, or in the displacement of the cultivated perimeters along a river's axis.

This movement of extension and regression of cultivated areas, considered for each river basin, occurs not only along a river axis, but also lateral to it, depending on how much the irrigation networks have been extended. This fluctuation took place until the nineteenth century and placed spatial discontinuity of the agricultural reclamation of the river basin of Transoxiana at the forefront of the regional conditions to be scrutinized through historical analysis. This spatial discontinuity of reclamation is in a sharp contrast with the impression of unity produced by the landscapes which surround the cities of Central Asia:

> It will be enough to say that along the road and as far as the eye can see on two sides, fields of any sorts alternate nicely with very old trees and real prairies as those that can be seen in Normandy (Ujfalvy de Mezo-Kovesd 1878: 104).

The large sedentary centres of Central Asia give the impression of unity and continuity, but they are in fact divided into smaller units: the irrigation systems of each main canal. The latter might disappear or be transformed, the surfaces under cultivation might increase, and all these operations can be run independently from each other. This is the reason why it is useful to closely study the micro-regional chronologies for a general understanding of Central Asian history. The diverse potentialities of each basin are considerably revealed during agricultural crises.

In addition, some river valleys have been divided between several principalities along the course of a river, creating political boundaries but not disturbing water operations along the streams; particularly water distribution to the hundreds of major irrigation canals. The best example here is the Zeravšân valley, where water operations were co-ordinated between Samarqand and Buxârâ.

Disruption and solidarity of spatial management are characteristics of diversion based river oases in Transoxiana. Each of these basins experienced a succession of periods of greater and lesser activity of agriculture. During periods of greater intensity, irrigation systems are improved, and their capacity increased, whereas during periods of lesser activity, agriculture occurs only in some portions of the previously irrigated command area, and uses only a portion of the existing irrigation system. One may assume that any main canal, which was in use in the nineteenth century, may have been inactive at some point during its history. In this development, creation of new canals or re-opening of old ones constitute operations with apparently identical significance.

The thousands of dams and dikes that must be open when the spates rise, the thousands of *čigir* that must be maintained, the countless canals which must be desilted, and the gates opened and closed at the right time. All this requires strict supervision that was handled by the governments of the post-Mongol khans. The re-use of previous systems, often rebuilt on the ruins of ancient irrigation networks received tremendous state authority which harnessed identical mechanisms and processes, and employed forced labour or slaves. For example, although there are many cases of creation of canals by Uzbek khans, construction and renovation are two operations, almost impossible to distinguish from each other in the post-Mongol era in terms of decision-making processes and social implications.

Finally, as a general statement, one may ascertain that the states of post-Mongol Transoxiana, all dominated by dynasties who originated from the Dašt-e Qibčâq and for this reason often perceived as a "nomadic element" in the historiography, quickly and skilfully assimilated irrigation management, an accomplishment which proved to be central to their societal importance.

The study of the names of the canals adds a useful complement to what medieval sources only hint at; the link between irrigation and the post-Mongol state, whose dynasties through their founder at least, had nomadic origins. The canal Daulat Qarâ Quz, for example, takes its name from a qunqrat dignitary of Xiva. In fact, state intervention occurs in all phases of irrigation, from the creation of the main canals to the organization of their cleaning by forced labour. All types of operations are inaugurated by the highest dignitaries of the Uzbek states.

There is also a question of whether or not there is a threshold of population density and productivity level which must be reached in developing large and complex systems where irrigation management would inevitably require the creation of social structures necessary to support their function. The successive states of the post-Mongol period could have chosen controlling these social structures, or rejecting them, promoting new economic strategies and drastically reducing the irrigated command area. The post-Mongol states, however, did not adopt new strategies and the question about the necessity of developing the features of the hydraulic society, which has been widely discussed in recent decade, remains far from being settled.

THE CONTRIBUTION OF THE STUDY OF IRRIGATION TO THE STUDY OF SETTLEMENT AND IDENTITY PROCESSES

The study of irrigation permits a better understanding of the history of Central Asian populations and of the variables which comprise their multi-faceted identities. One of the most important aspects of this study is to compare information gathered on irrigation as a social and economic factor with the representations of the history of post-Mongol Central Asia and their reflection in the European geo-politics of the eighteenth and nineteenth century.

European travellers were much more likely to visit Central Asia during that period than at any previous time, despite, or perhaps because of the fact that the main European empires were never authorized to maintain permanent diplomatic representation in the area. One of the main aspects of this legacy is an enormous corpus of travel books, which is added to the travel books left by non-European travellers, especially Persian and Chinese. Russian travel books are by far the most numerous. They are full of descriptions of fortifications in disrepair and ruins of irrigation canals which were passed during the several-week-long journey from the Russian boundary at the Orenburg and the pre-Altay defensive lines. Russian travellers not only observed that the steppes had an "air of desolation", but they also were persuaded that the astonishing number of ruins was proof that history of such regions was essentially that of disruption and disorder.[33] There is no doubt that the Orientalists' historical perspective of the last century of the Uzbek khanates and the other Central Asian states were produced by the "cultural shock" of travel. Reflections on the lost prosperity of the area, tracing parallels between the political disorder and moral decay of the inhabitants, a result of the decline of sedentary lifestyle, constitute a certain vision of the history of the settlement of Central Asia and of the place of nomadic migrations in this process. For example, in the introduction of his book on southern Central Asia, for example, Nicolas de Khanikov writes:

> Never in its past, has this country presented a period of constant development, never was it the seat of a consecutive series of facts which might have attracted to them the attention of the World. Its past is particularly feverish ... (Khanikoff 1851: 3–4).

Since the period of the discovery of the Central Asian region took place within a pre-colonial and colonial context, our knowledge of the region not only expanded but was renewed by the mass of information provided by archaeology, particularly the archaeology of irrigation. It was already known that the large irrigation systems in Transoxiana, for example, endured much severe destruction throughout time. It was assumed that the migrations of nomadic populations had provoked significant disruption to the irrigation systems, resulting in the dramatic consequence that this destruction was linked to the history of settlement. Archaeological studies now prove that in the sequence of events related to the history of settlement, many migrations had little long-term effect in regional destinies the cause of long-term disruption in regional destinies. There is impressive archaeological literature concerning each large river basin. This literature tends to indicate that the case of Khorasan, which did not recover after the Mongol invasions is not representative for all Central Asia.

During the entire post-Mongol period, the socio-economic and cultural diversity of communities, as well as of individuals, was derived from status, elaborated in terms of nomadic or sedentary categories. Heavily symbolic, these categories were the vehicle of representations that played a significant role in the making of social identities.[34]

Beyond the representations, the population categories present in Transoxiana have an internal diversity. Many of the groups possess economic or other traits which are supposed to characterize the opposite category. In addition, when the socio-economic structure of the populations of Transoxiana is schematically presented, Transoxiana is too often reduced to its sedentary, agricultural and urban facets. Indeed this sedentarity pole is also the home of a great number of pastoral or agro-pastoral communities, having more or less extended cycles of seasonal migration. Numerous questions have arisen concerning their existence, and it was too often a matter of misinterpretation.

History of climate was at one time at the forefront of theories aimed at elucidating the disrupted evolutions of the studied regions and the link between type of settlement and economic and cultural prosperity. This material as such merits examination, as a testimony of the evolution of conceptions that Orientalists fostered regarding the impact of nomadic populations on sedentary Central Asia, whether they were linking nomadic migrations with climate or not. Concerning the last of these nomadic migrations toward Transoxiana, that of the Uzbeks (*circa* 1490–1510), the Baron Georges de Meyendorff wrote in 1820:

> Since the end of the domination of the Timurids in the city of Samarqand, the Uzbek khans settled in Buxara, and some of them have built mosques and medresses, while extinguishing the love for sciences and arts, and erasing the remains of a civilization which was foreign to the customs of these nomadic peoples (Meyendorff 1826: 165–166).

Any hypothesis concerning climatic evolution is necessarily a conjecture on river activity. Many specialists today would agree to the hypothesis that proposes a continuity of climatic factors throughout the historical periods. This theory implies much about the natural milieu of Central Asia, which we need to know better. However, it is impossible to evaluate the consequences of the minor climatic variations that have occurred since the Holocene period. They are particularly complex in an arid environment.

In the eighteenth and nineteenth centuries, when the first Orientalist works were produced, the overwhelming majority of the nomadic and semi-nomadic populations of Central Asia were Turkic speaking. This statement, although correct, has given rise to many misunderstandings and misrepresentations. Indeed, nomadic, tribal and Turkic factors have too often been confused due to an overestimation of some traits of long-term evolution in Transoxiana and in other Eurasian regions. New elements in the ethno-political evolution of Transoxiana since the end of the Samanid dynasty (end of the tenth century) trace their origin from the steppes, predominantly nomadic, and were organized along powerful tribal confederations.

Nevertheless, nomadic, tribal and Turkic factors are three historical heterogeneous variables. Any suggestion that they automatically converge is unacceptable[35]:

1. Pastoral nomadism is a form of food-production that has existed parallel to irrigated agriculture since the beginning of the first millennium BC. It has therefore no structural bond with the history of the Turkization in this region.[36]
2. The role of nomads in the history of Transoxiana, whether or not of Turkic origin, is certainly not to be viewed only as predation. Nomads, however, have been portrayed as predators by many cultures, not only in Europe, but also in local representations of many Asiatic sedentary cultures. Nevertheless, long lasting nomadic-sedentary contacts were characterized not by lack of uniformity, but to the contrary, by an impressive diversity in political, economic and cultural relations. At the end of the nineteenth century, for example, not only a probable majority of Uzbekophones in the Uzbek khanates were agriculturists, but also the majority of peasants in Transoxiana were Turkophone, mainly Uzbekophone.

Therefore, it is impossible to assign any ethno-linguistic status *a priori* to the nomadic or to the sedentary factors. In addition, as an aftermath of ethno-political reconfiguration cycles in the history of the region, many Central Asian societies are likely not to be defined as solely pastoral nomadic or sedentary agriculturist, but rather as semi-nomads (Karakalpaks, Yomut Turkmens etc.), particularly if viewed on their long term evolution. Differentiated societies do exist, although with a very wide range of variations *vis â vis* the nomadic or the sedentary "standards".

If one postulates that after the Mongol conquest and the appropriation of the Gengiskhanid heritage into the ideology of the Muslim Turkic states of Central Asia, no political powers completely vested their legitimacy without reference to the Gengiskhanid motive and set of values, one realizes how long, original and significant the post-Mongol period was for Central Asia. It occupies a singular place in central Muslim lands. Indeed, the Gengiskhanid influence did not vanish (as in Iran), nor major socio-religious changes (i.e. Islamization and Turkization) were provoked by a single series of conquests (as in Anatolia after the Manzikert battle in 1071 opening the region to Seljukid conquest). The preservation of the Arabic culture, which opposed the expansion of Ottomanism in Ottoman Egypt, has no cultural equivalent in Transoxiana or western Central Asia. Compared to other areas of central Muslim lands, Central Asia was and has remained a region of fusion in political, institutional and cultural terms. There is, however, a sharp and restless opposition revolving around the conception of sedentarity and pastoral nomadic populations, and it has remained a fertile platform for further social tensions and transformations.

By the end of the Timurid period (end of fifteenth century), Transoxiana was the home of a largely Turkicized population, and the large nomadic confederations living on the inner steppes of Transoxiana or in the great steppe to the north Transoxiana had already developed an Islamic identity.

The major binary opposition present throughout Central Asia and which was operational among many reference groups as a symbolic system to point out "otherness" is the binary opposition between nomadic and sedentary. One may note that within the group of sedentary agriculturists, there is a sub-opposition between agriculturists using irrigation, the overwhelming majority, and those who benefit from the rare areas where pluvial agriculture is possible. The most common term to designate the land cultivated under pluvial conditions in the written sources and in the spoken languages is *lalmi,* among Turcophone and Iranophone populations, for any category of land. It has many local variants, such as *lolim* (Nurata area), *lolami* and *lyalyama* (area of the Čirčik basin), *yalm* (Xuf valley). Kazakh communities of the Čimkent oasis use the term *talme*. A very common term also for all categories of lands cultivated under pluvial conditions is *kayraki,* which is likely more used by the Turkophone communities. Some other terms are found in more ancient sources, but they fell into disuse before or during the post-Mongol period.

This means that local distinctions between nomadic and sedentary, although indigenous, are not a direct interpretation of an "objective reality". They constitute symbolic systems depending on an extreme variety of nuances existing from agriculture to pastoral nomadism (or vice versa), and also within any community's historical evolution. They emphasize the distance between a given community's lifestyle and the "nomadic" or "sedentary" standards. In fact, the latter fluctuate as much as the countless nuances and adaptations, and are mediated by many other standards, or systems of references, ethno-political or socio-cultural. This complex relationship between realities and their interpretations, both fluctuating and echoing each other, is very fertile in terms of identity creation. Many, if not all of the names of the main nations of Central Asia existed in history as socio-economic as well as ethnic markers, fluctuating in space and time between these two functions. It is during the twentieth century that their definitions was only provided in ethnic terms, at the exclusion of their other previous facets. For example, in an area like the Dâšt-e Qibčâq, where pastoral nomadism was largely dominant but where existed several types of migrations, some groups were perceived as "more nomads" than others. Indeed the Adai confederation of tribes, living in the Mangislaq area on the Caspian border, were viewed as the "very nomads" according to the qâzâq standards. In both Transoxiana and the Dâšt-e Qibčâq, terms like *qâzâq* were meant for nomads and *sârt* for sedentaries. Attributing them a sole

Uzbek or a Qâzâq national status as it was done later in this century is equally reducing.

Indeed, there exists a large scope of appellations and statuses, whose function depends on how each group recognizes itself, and on how its neighbours recognize it, whether a supposed or real nomad, or a sedentary being. The compilation of terms evoking this diversity in written sources or in ethnographic surveys is meaningful only when supplemented with a comparative study of the natural environment in which these communities exist.

Therefore, by attempting to define environmental and ecological characteristics, the history of irrigation permits the investigation of innumerable terms which mirror complex economic-cultural identities by local groups. Their variations, which convey expressions of "otherness", are useful for studying mentalities and for making cultural typologies.

Considering the *longue durée,* the history of irrigation may be regarded really as a tool for approaching the social and cultural history of medieval and modern Central Asia. This is at least the case for periods when the previously mentioned opposition prevailed. Then, new systems of thoughts since the late nineteenth century redistributed opposition factors. Proto-nationalisms recognized a common bond between groups of diverse economic-cultural affiliations (for example between agro-pastoral, pastoral, sedentary agriculturists and urban communities), and before the advent of the Nationality policy of the Soviet state, Jadidism played a role in this process in Transoxiana after the 1880s.

CONCLUSION

The nomadic and tribal characteristics of the dynastic groupings dominating post-Mongol Transoxiana were not, as such, sufficient for disrupting the mode of development in medieval and modern southern Central Asia. Indeed, this region was already structured on a conjunction of natural and human factors, constraints arising from the environment and the decision to irrigate. This is why on the irrigated domain of western and central Transoxiana, the Turko-Mongol nomads arriving from the cold steppes did not encounter conditions upon which they might have transformed irrigated land into pastureland on a large scale.[37]

In conclusion, it may be proposed that the study of irrigation allows the refinement of our knowledge of the spatial structures of Central Asia throughout history and of the constitution of its various historical entities. Our knowledge of the internal organization of these historical entities should also greatly benefit from a further study of irrigation. It is worthwhile, for example, to point out the correlation between the limits of the desert climates of Transoxiana, the hydrographical area of the so-called Aralo-Caspian basin and the Uzbek political-space within which khanates formed themselves between the sixteenth and the nineteenth centuries. In addition, the highest concentration of sedentary populations during the Uzbek epoch is located on rivers chiefly fed by glacier or glacier-snow melt. This is the best way to maximize watering opportunities, during the peak of the warm season, and the growing season, particularly for cereals and leguminous plants, which constitute the basis of popular sustenance.[38] This is the reason why, despite Transoxiana often being viewed as the southern sedentary part of Central Asia, one might witness there a sharp opposition between the western desert sector, which offers vast space for low density nomadic populations, and the central and eastern sectors, which are the very domains of irrigation and sedentary population in the post-Mongol time.

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NOTES

1. There is a striking contrast between the average discharge of the Amu Daryâ which is over 9000 m^3/s, and the discharge of the small Šargun river (Central Uzbekistan), the average discharge of which is 0.91m^3/s, or the discharges of the small torrents that flow from the Kopet Dag.
2. Some lakes in the Aral region, some springs in mountainous zones and *xâk* (tanks) in the Qarâ Qum desert permit the creation of small diversion canals.
3. Aridity in Central Asia varies considerably from one region to another: values for the north-eastern portion of Ferqanah, with an average fifty millimetres of precipitation per year sharply contrast with the not-so-distant city of Penjikent, which receives an annual average of precipitation of 400 millimetres.
4. The question of the *karez /qanât* is not touched upon here because they are of marginal importance in the irrigation of southern Central Asia, except in some micro regions.
5. This term is used in Uzbek to designate the "irrigation canal", most often the secondary or tertiary canal.
6. Tajiks of Western Pamir or of Badaxšân live in the valleys of two tributaries of the right bank of the Panj, the rivers Pamir and Vaxân Daryâ. Their villages are located at altitudes between 2500–3200. Only irrigation allows crop cultivation on small field terraces (size are often above 100 m^2), cf. Kreutzmann 1996, Muxiddinov 1975: 5–6, Muxiddinov 1984.
7. Concerning the usage of manure in the oasis of Xiva, *see*, Ivanin 1873: 39–40, Škapskij 1900: 78 and passim.
8. *Kok qâmiš to šuvi,* the "flood of the green reed", occurs in the second half of March; *âq bâliq to šuvi*, the "flood of the white salmon", in mid-April; *yulduz to šuvi*, the "flood of the star", in mid-May and *qirq čilgov to šuvi*, the "flood of the 40 hot days", at the end of July. These names, which refer to fish, constellations or season of the year witness the scientific and cultural activity of medieval Xvârezm, Guljamov 1957: 237–238. The dates indicated here for the floods of the Amu Daryâ are of contemporary origin. Some older estimations show a slightly different calendar for them. For example, Danilevskij (1851: 76) mentions the first flood in February, the second in April and the third one at the end of August and at the beginning of September. However, he notes that the volume of water carried by the river changes approximately every ten days.
9. *Qalami quli to šuvi* (the spate of the blossoming tuft of the reed), occurs in mid-March, then, two months later, *olma quli* ("the apple tree flower") supplies natural and artificial irrigation with its sudden high waters, Muxamedžanov 1978: 120. Finally, some other high water periods supply the needs of cultivated crops until the end of summer.
10. The first spate takes place by the end of March, and it coincides with the festival of *Nauruz*. This is the reason why this spate is also called in some popular traditions *Bahavuddinning suvi*, "the water of Bahauddin", for Allah would have sent it to the great *šayx* of the Naqšbandiyya brotherhood in order for the *šayx* to do his ablutions and to be ready in terms of legal purity to celebrate *Nauruz*, Muxamedžanov 1978: 119. The other name of this spate is *narzob*, Ibid.
11. Haudricourt and Hedin 1987: 73 *see*, the map "Carte de la densité en espèces de la végétation du globe, d'après E. Wulff".
12. Guljamov 1957: 244.
13. Barthold 1963–79: 122.
14. These words are not only colloquial, but also used in the written form. They are found for example in al-Kazmiri's *Rauzat ar-Rizvân* (work of the end of the sixteenth century), Abduraimov 1968: 123. Within the same text, these two terms may serve to designate

canals which seem to be of the same kind. *Nahr* is likely to apply to the head portions of a canal, *šurakoy* is likely used to mean a construction built by a community, *see*, Mukminova 1966: 327–328.

15. Danilevskij 1851: 82–84.
16. One *versta* is equivalent to 10,668 kilometre.
17. One *sažen* is equivalent to 2,13 metre.
18. The complete list is given by Danilevskij 1851: 82–84.
19. Ibid: 79.
20. Mukminova 1966: 328.
21. Moser (1894: 215–216) describes the technique of filtration observed in the oasis of Samarqand.
22. From the Uzbek verb *čikarmok*, "to lift", to "extract".
23. For example, the rumour that a dam had been built on the Uzboy by the Khivians to prevent the Amu Daryâ from flowing into the Caspian Sea convinced the Czar Peter I to send the first Russian military expedition to Central Asia. In the internal political life of the Uzbek khanate, the utilisation of dams to prevent villages or revolting regions from being provided with water is common on the behalf of the Shaibanid powers and the successor dynasties.
24. Muxamedžanov (1978: 234) lists Russian sources which indicate these proportions and measurements.
25. Babaxanov 1959: 44.
26. Muxamedžanov 1978: 248.
27. Excavations carried out in 1962 enabled the examination of this arch and the remains of the two other arches. The results and sketches were published in Muxamedžanov 1978: 265–271.
28. Masal'skij 1913: 423.
29. Moser 1894: 172.
30. Abdulxamidov 1974: 25–26.
31. Moser 1894: 253–269.
32. Fourniau 1988: 592.
33. Levchine 1840: 107–115 has a chapter on this matter called "Ruins".
34. One of the common terms in Uzbek khanates' sources to designate communities according to their statuses, are the Persian terms *sahranišin* for the pastoral nomads, and *dexnišin* for the sedentary, Ivanov 1958: 71. In contemporary Uzbek, *kučmanči* is most commonly used for pastoral nomad, and *utrok* for sedentary.
35. Tapper 1983: Introduction.
36. Francfort 1990.
37. Fourniau, V. "Le Semiretchie et la Transoxiane: leurs liens dans l'histoire des turcisations et des sédentarisations en basse Asie centrale", *Mélanges offerts à Xavier de Planhol*, Institut français de Recherches en Iran, forthcoming.
38. The everyday food of Khivians, for example, is composed of three to four flat breads for one person and a kind of porridge called *sikmân*, made of Indian millet (sorghum), lentils, pumpkins and watermelons, Škapskij 1900: 55.

5

Social Organization and Irrigation Systems in the Khot Valley, Eastern Hindukush

Israr-ud-din

INTRODUCTION

This study describes the rural society of the Khot Valley in the context of the social organization of its irrigation system. It emphasizes the physical condition of the system, certain rights connected with entitlements of the irrigation network developers and the fine-structure of the spectrum of water-titles. Elucidating the details of water management, we reflect on the evolution and social organization of irrigation networks in the Hindukush. For this case study, a community of irrigators has been selected in the Hindukush mountains. The community forms an integral part of the former principality of Chitral, which nowadays is a district of the North-West Frontier province of Pakistan.

Khot Gol is a side valley of the Torkhow River, which is a tributary of the Chitral River (Fig. 5.1). The valley lies about 120 kilometres north of the town of Chitral. The Khot Gol emerges from the confluence of Wermin Gol and Potiano Gol and drains the eastern and southern part of the study area. The length of the valley is about 55 kilometres, varying in altitude from 2100 metres to 3000 metres. The higher grounds above 3000 metres are covered mostly with grasslands and are used as pastures. The extreme upper reaches of the valley contain a considerable number of glaciers that feed the Khot stream during the late spring and summer months.

There are seventy settlements in the valley. The habitations are located on terraces or on gently sloping hillsides that provide enough flat land to be cultivated. The climatic conditions of the area are arid; it receives less than 250 millimetres of rainfall in the lower parts of the valley. The precipitation in the upper elevations of the mountains generally exceeds 350 millimetres.

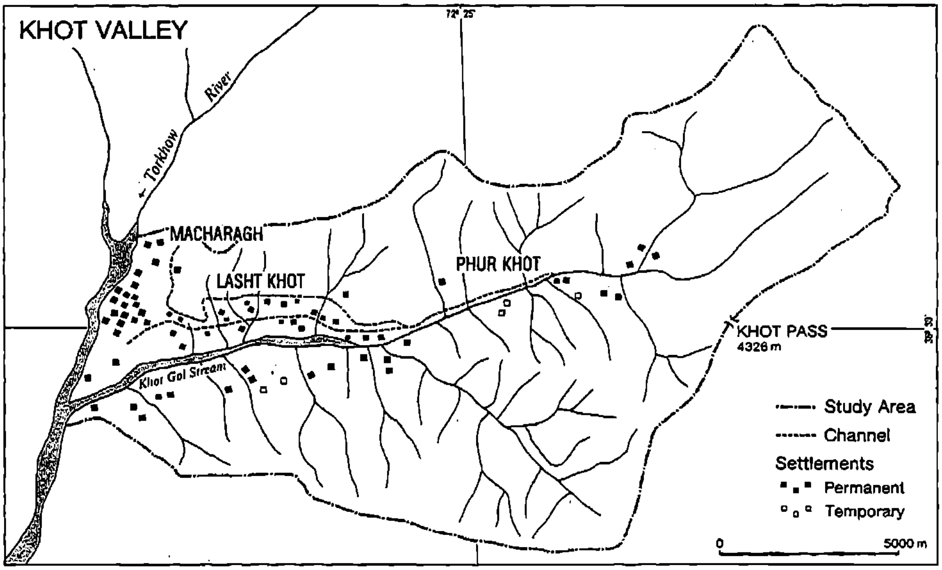

Figure 5.1: Map of Khot Valley.

Most of this precipitation occurs during the winter and early spring in the form of snow. These snowfalls are very useful because they facilitate early nourishment of the winter wheat crop and are the source of the springs, streams and glaciers upon which irrigation is dependant. Very little rain occurs during the hot summers, which makes irrigation necessary. Occasionally torrential rains and flash floods cause substantial damage by destroying irrigation channels and field crops.

The mean temperature of the hottest month is about 27°C and the maximum temperature of the hottest month is approximately 30°C. The length of the growing season ranges between 210–240 days, which is sufficient for various crops to mature, though only one crop is cultivated. There are five months with temperatures below freezing; the danger of frost is common.

The study area is drained by many tributaries of the Khot Gol. The discharge of water in these streams fluctuates over time. June to August are the peak runoff months when streams are frequently in flood due to the melting of snow and glaciers. However, the water never dries up in these streams. Some areas of the region are also endowed with springs, which are used mainly for domestic purposes.

BASIC CONDITIONS OF AGRICULTURE

Large tracts of rich pastures are found in the valley, thus equal importance is given to both agriculture and animal husbandry. Both sectors are interrelated and subject to household management practices. Crops include wheat, barley, maize, beans, and potatoes (Tab. 5.1), which are common to the whole area. The Khot valley lies above the upper limit of rice cultivation in Chitral.

Tab. 5.1
The cropping period of various crops in Khot Valley

Crop	Sowing	Harvest
Winter wheat *(sharegh, Triticum aestivum)*	October	End of August
Summer wheat (*basindi*)	March	Early August
Summer barely (*Hordeum vulgare*)	March	July
Maize (*Zea mays*)	Early May	September
Millet (*Setaria italica*)	April-May	August-Sept.
Beans (*Vicia faba*)	April	August
Grams (*pulses*)	April	August
Potatoes (*Solanum tuberosum*)	Early May	October

Source: compilation by author

Due to the high altitude, fruit trees including apples, apricot and walnut are planted only on a limited scale. The rotation cycle of crops is as follows: barley (one year), wheat (one year), millet or beans (one year), fallow (one year) or *shaftal* (clover) (one year) manured and then wheat or barley. Thus the rotation cycle is completed in four to five years. With mineral fertilizers becoming increasingly available, however, many farmers prefer to grow wheat on the same field each year.

Animal husbandry includes bullocks, cows, goats, sheep and yak. Most households possess some livestock, although flock sizes may vary significantly.

Almost all the farmers are owner cultivators. A few absentee landlords possess more than 40 hectares of land, but the majority of households are small landowners possessing less than 1 hectare.

While water for irrigation is abundant, since only one cropping season is prevalent in the area and land holdings are small, the farming communities survive mainly from subsistence production. A growing number of people from the valley have migrated to the Gulf states or to the major urban areas of Pakistan, over the past two decades, in order to supplement their incomes. This phenomenon has helped agricultural development in the region because this income has increased the farmers' ability to purchase inputs, such as mineral fertilizer, improved seed, and pesticides.

IRRIGATION PRACTICE AND ITS HISTORY

Like in most parts of Chitral, irrigation is a basic requirement for agriculture in the Khot Valley. Rainfall is low during the late spring and summer seasons, which are the critical periods of crop cultivation. On the other hand, water is abundant in the streams of Wermin and Potiano Gol due to the melting of snow and glaciers which has made channel irrigation possible. Most parts of the valley are irrigated by an approximately 40-kilometre long canal network. A number of villages situated along the stream, however, are irrigated by small channels, which serve each settlement.

According to local tradition, the founder of the Baikey clan established the main channel *rajoi*, about five hundred years ago. At that time, the Baikey and Khoshey clans were the pioneer settlers of the area. Initially, the channel was constructed up to Bokhan Dur, which is five kilometres from the source. During the second half of the nineteenth century, it was extended to a place called Macharagh. At the same time a branch was also excavated from Bokhan Dur to a location called Langar. In the early twentieth century, the channel was extended from Langar to Zang Lasht.

Forty-nine settlements from Rajoi Macharagh with 471 households are fully benefiting from the irrigation system, and fifteen settlements with 492 households are partial beneficiaries. Similarly, Zang Lasht Joi serves six settlements with 200 households' full beneficiaries, while fifteen settlements with 492 households receive partial benefits from this channel.

THE PHYSICAL ASPECTS OF THE IRRIGATION SYSTEM

For convenience, one can divide the channel into the following parts: from the head works (*hurdur*), one proceeds downwards to the overflow and desilting sluice gate (*madok*) before the proper channel connects the source *(urfi)* with the village lands. From these, several channel extensions take off supplying irrigation water to the secondary distributaries.

• Hurdur (headwork)

The headwork or *hurdur* lies near a place called Phur Khot, where the channel has been diverted from a perennial stream called the Wermin Gol. The wall of the channel has been extended into one side of the stream in

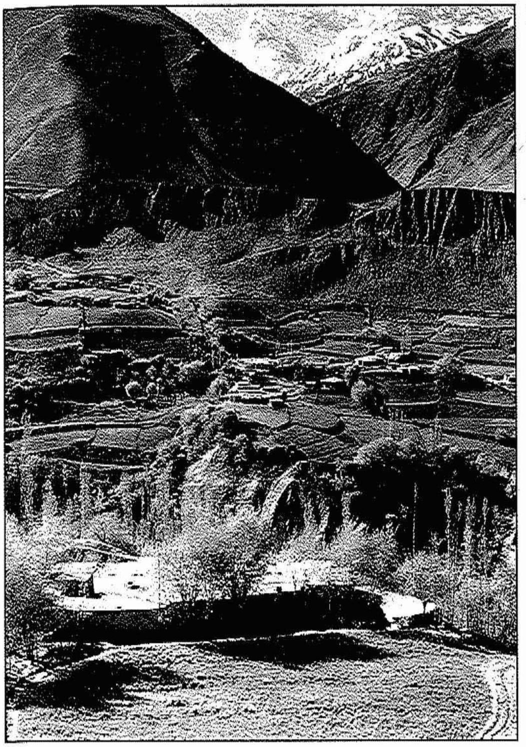

Photo 5.1: A view of Khot. The irrigated village lands are interspersed by habitations and rows of trees along channels (Israr-ud-din).

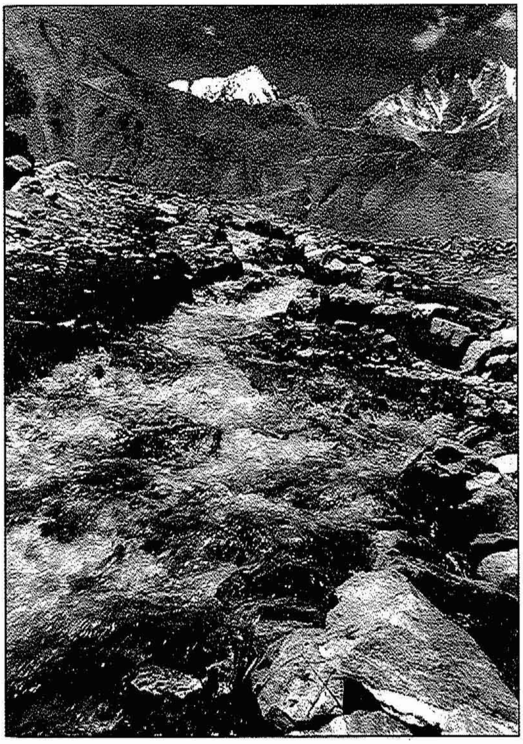

Photo 5.2: Channel flow above Khot village during the summer season (Israr-ud-din).

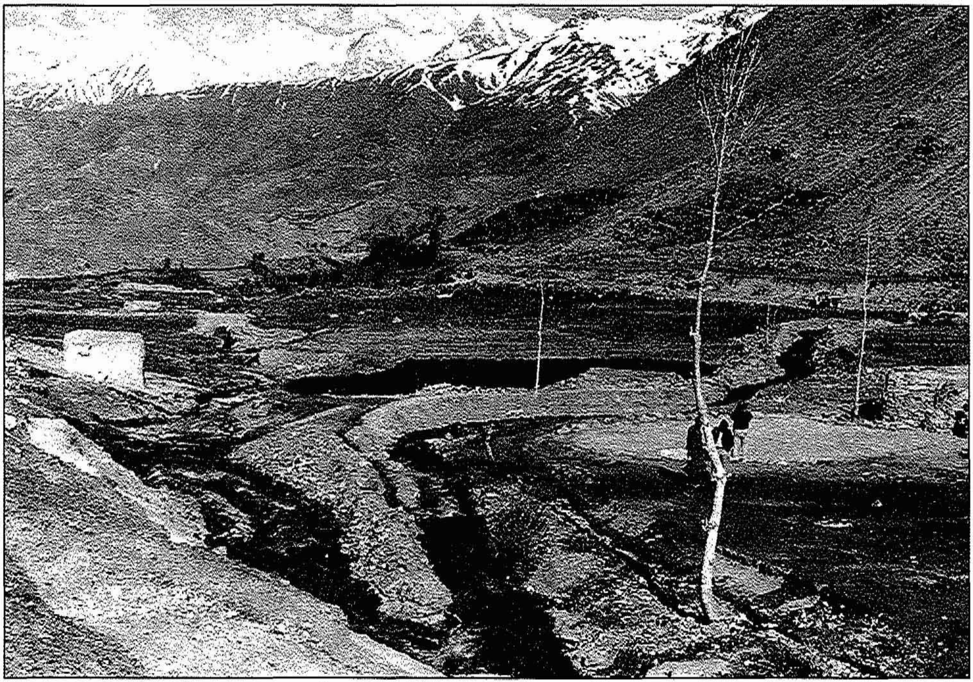

Photo 5.3: Bokhan Dur junction where irrigation channel water is diverted into different sections of the village lands (Israr-ud-din).

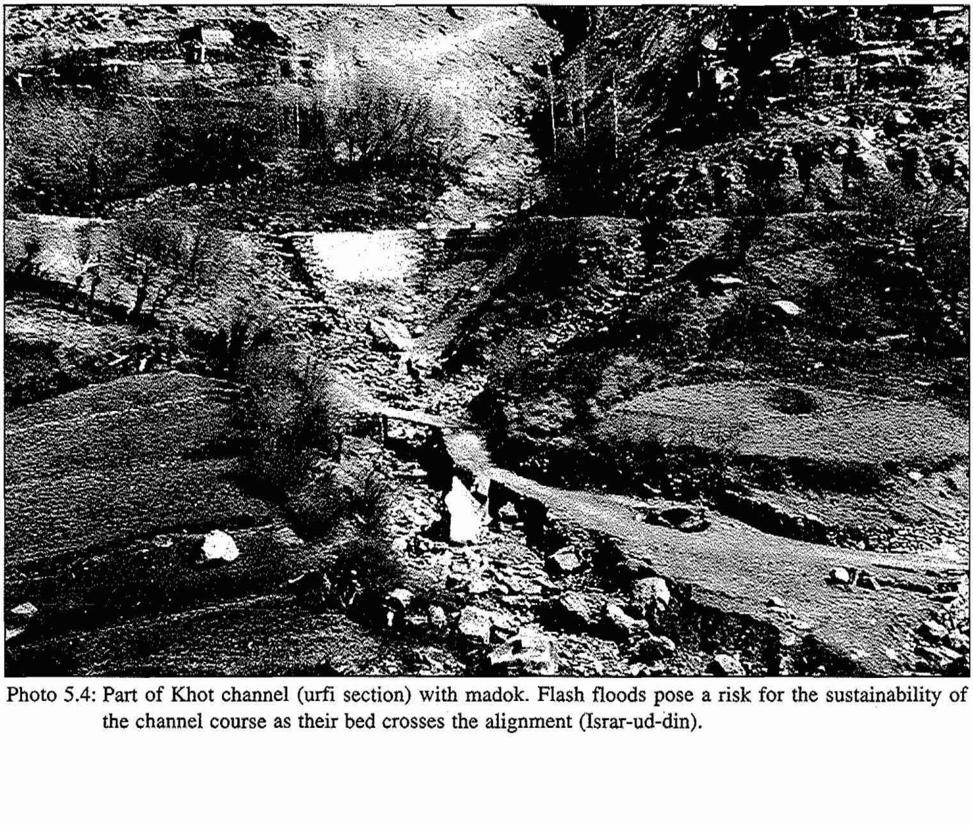

Photo 5.4: Part of Khot channel (urfi section) with madok. Flash floods pose a risk for the sustainability of the channel course as their bed crosses the alignment (Israr-ud-din).

such a way that sufficient water can funnel into it easily. However, during the period between September and October, when the water discharge is low, a weir is built across the stream so that the ponded water can be diverted into the channel. The channel is 5.5 metres wide and 1.25 metres deep at the headworks and carries about twenty "mill" of water. The discharge of water in a channel is locally measured in terms of the amount needed to run a water mill. This measurement varies from place to place because of the size of the mill-stone. However, the average measurement of one mill of water (abbreviation "m-w") will be approximately 3 cusecs.

At the headworks, sixteen to forty-eight persons perform duty around the clock during the high flow period. During the off season, fewer people are needed to control the discharge. A large amount of water flows back into the stream because of the loose stones dumped there to function as a wall. It is difficult to make a solid or cemented structure because of the torrential flow of the stream during flood periods and, therefore, maintenance personnel must be on duty at all times during that period. The Irrigation Department of the Government of Pakistan may be helpful in improving this situation by introducing new technology.

- **Madok (overflow and desilting sluice gate)**

About 400 metres below the headwork at Shel Gram, there are two wooden sluice gates, called *madok,* situated at a distance of about 100 yards from each other. These gates are 2.3 metres by 1metre by 0.5 metres. At these places the channel is widened and deepened to form a tank 8 metres x 1.6 metres deep. The gates are "V" shaped, the cone pointing downwards, and are opened two to four times daily so that the silt gathered there can be drained out into the main stream. These gates are also used to close the channel in times of emergency, such as when the channel breaches during floods. After opening the gates, the water flows for an hour or two so that the deposited matter is cleared. The wooden sluice gates slide through wooden frames that are fixed in a wall made of stones with wooden beams.

Five people are on duty daily at the *madok*, three at night and two during the day. The daytime duty is called *wali* and the night duty is called *basi.* These services are provided, in turn, by different households according to fixed rules. The wood for the gates, frames and wall of the *madok* are also provided by certain irrigators according to set rules.

• Urfi (main channel)

The main channel was initially constructed as far as Bokhan Dur and then was extended to a place called Langar near Puchung, 20 kilometres away from the headworks. This part is known as *rajoi* or *urfi*. The channel runs along the mountainside and at some places it also passes through the plains area. The *urfi* section serves twenty eight settlements including: Gol, Dur Zach, Sharastun, Barun Dur, Dukan, Unzuk, Khacho Maht, Dukan II, Maran Deh, Dodan Dur, Babaqan Dur, Ragh, Mahjo Muri, Lasht Dur, Choghan Dur, Thor Khot, Orwaht, Nazaran Dur, Lasht Dur II, Daghar, Puchung, Fallan Dur, Daghar II, Hon, Fardagh, Hunkut, Langar and Lugar. These settlements are inhabited by 200 households. At this point the width of the channel is 5.5 metres and the depth is 1.2 metres.

• Extended parts

During the past 150 years, the main channel has been extended further in two phases. First, about 150 years ago, it was extended to a settlement called Macharagh. Therefore, this section is now known as the Macharagh Branch. The length of this branch is about 20 kilometres with a width of 3 metres and the depth of 1 metre. It serves the following settlements: Bokhan Dur, Onzuk, Maran Deh, Fallan Dur, Daghar, Bichano Kurkoon, Hon, Thorkhot, Orwaht, Gochar Korini, Dok, Lasht Dur, Daghar II, Moshan Dran, Lowak Dini, Biaso Lasht, Sheno Kham, Panjian Tek, Khamara, Phum Barash, Kamara II, Ashur Shal, Macharagh, Dok Macharagh, Shashik, Paloom Gol, Bakh Gol, Saroza, Ramanich, Zang Tek, and Uzhnu. These settlements comprise about 250 households.

Approximately fifty years ago a parallel branch called the Zang Lasht was constructed from Bokhan Dur to Zang Last and Uzhnu. The length of this channel is about 32 kilometres and has the same dimensions as the Macharagh branch. It serves the following six settlements: Upper Rabat, Shol, Kashun, Zang Lasht, Lower Rabat and Orwaht. The settlements are inhabited by more than two hundred households.

• Distributaries

Thirteen distributaries have been diverted from the above channels to irrigate different areas which include: Chat Joi, Muzho Joi, Pongo Joi, Ugh Bojone Joi, Raho Joi, Charogho Joi, Nishito Joi, Babaqan Dure Joi, Kalar Nigialo Joi, Orwahto Joi and Pchongo Joi.

Structural Problems of the Irrigation Network

Different factors contribute to the loss of water, the interruption of proper water flow and have a hazardous impact on the physical structure of the system.

- Seepage: The entire channel is unlined and passes through soft alluvial-cum-morainic soils. Seepage is a problem and considerable water is wasted before reaching the field plots. As noted above, even at the headworks, almost one third of the water passes back into the stream through the rough stones used for creating the weir. This loss of irrigation water is severely felt, especially during periods of water scarcity.
- Silting: The water carries considerable amounts of suspended matter during the runoff period. While the *madok* substantially reduces the siltation, the channel often becomes choked with silt and requires additional cleaning at least two or three times a year.
- Landslides: Various locations are prone to landslides and the danger of the channel breaching is ever present. Therefore, around the clock vigilance is essential at fragile points threatened by natural hazards.
- Flash Floods: Flash floods may occur at different locations along the course of the network during summer rains. Flash floods in the source stream frequently wash away the headworks resulting in the closure of the canal until it is repaired. Flash floods from hill torrents often result in a breach of the main channel, causing tremendous damage to fields and houses. These damages cause not only loss of property, but result in many days of labour for maintenance and repair.

In recent years, through the provision of Government grants, concrete aqueducts have been constructed over the channel in the damage prone areas. These constructions, however, have frequently proved to be inadequate. Moreover, the *bazanu,* or old emergency gates for draining water out at these places, have now been closed and thus increase the danger of damage to the channel as well as to nearby settlements.

SOCIAL ORGANIZATION

The maintenance of the irrigation network is safeguarded by certain office-bearers and groups of villagers who co-operate in times of need.

• Merjoi (chief of the channel)

The *merjoi* is the pivotal figure regarding the management of the channel. He is the local authority in charge of the various affairs related to the irrigation system. He is fully responsible for the welfare of the channel and decides when to repair it, when to open it and when to close it. The *merjoi* also looks after the distribution of water between the different groups of households, called *phi,* and supervises the ways in which the *phi* perform their collective irrigation-related responsibilities.

There are two *merjois* on the *urfi* (main channel) portion, and two for the extended parts. They also have assistants to support them. One of the *urfi merjoi* is the paramount figure in charge. The main *merjoi* has the authority to fine defaulters and resolve conflicts occurring between irrigators. At times, he also consults selected elders of the community or *yuft* to settle such conflicts. The *merjoi* and their assistants are paid according to fixed rates by all the members of the various irrigator groups *(phi).*

The appointment of the *merjoi* was once hereditary, being the head of the Baikey clan who claim to be the founders of the channel. He was also appointed as the chief or *aqsaqal* of the valley by the hereditary rulers. The *merjoi* once enjoyed executive authority over the irrigation community and was equipped with ubiquitous powers in various political and social matters. This not only enabled him to assert his authority in respect to the social organization of the channel, but also contributed to the establishment of traditional patterns. The hereditary system continued until 1970, when the other clans objected to the system and through a consensus decided to appoint a *merjoi* on a rotational basis. This development coincided with the abolishment of state power then in the hands of the Chitrali rulers and the integration of Chitral into the administration of the North-West Frontier Province. Currently, the chief *merjoi* is selected for a four-year term from among the three clans of the *urfi* portion of the channel (Baikey, Khoshey and Pathani). Thus each clan, in its turn, nominates a person keeping in view of his organizational capabilities. It has become increasingly apparent, however, that with the passage of time, the chief *merjoi* has been facing difficulties in asserting himself, as he lacks the political authority once enjoyed by the hereditary *merjoi* of the Baikey clan in the past.

The *merjoi* of Macharagh and Zang Lasht branches are appointed through election or sometimes by selection by the respective *phi* in view of their irrigation knowledge and professional capabilities.

• Waldoyo (emergency maintenance groups)

Two Waldoyo remain on duty round the clock at two locations (Romain Zomalu and Lasht Driano) which face severe land slide problems and where there is always the danger of a channel breaching. The watchmen must remain constantly vigilant and operate out of huts called *prakal,* built for shelter near the calamity prone sites. The watchmen are provided by the various groups *(phi)* in turn.

- **Joiwal (watchmen)**

The *joiwal* are those who remain on duty along the course of channel to regulate the distribution of water. A number of them remain on duty at the headworks to ensure that damage is kept to a minimum or to see that repair work is mobilized on the channel. Their numbers vary from time to time. During the flood period, for example, as many as forty-eight persons may remain busy with maintenance activities. When the threat of flooding diminishes in late summer, however, the number of the workers involved in repair and maintenance is greatly reduced.

Five persons remain on duty at the *madok* according to rules prescribed among the *phi.* Three of these individuals are on duty twenty-four hours a day, while the remaining two are on duty only at night. Their job is to open and close the sluice gates and look after the channel to Bokhan Dur.

The Phi System

Phi literally means a wooden shovel, but in Khot it is used to designate a group of people. All the different village communities have been grouped into sixteen *phi*, entitling them to an allocation of water but also requiring them to perform duties in connection with the management and maintenance of the channel. Originally there were only two *phi*, but later this number was increased to three. At the present, due to the extension of the system, the number of *phi* has been increased to sixteen over time.

The rights, roles and duties of the irrigators are fixed according to the *phi.* Changes in the number of families or the size of the families in a *phi* does not affect their original rights, roles or duties. Some of the rules are as follows:

The various *phi* each have differing numbers of members. The membership of each has been fixed and cannot be altered. The actual number of families that could be members of each phi is greater than the fixed number, but to add them would affect the allocation of water or other duties already assigned to the group. The sharing of roles and duties is then made within the group itself without affecting the general system. For example, the smaller the membership in a *phi,* the greater the share of water for each family. On the other hand, a *phi* having a larger membership would be at an advantage in having more members to share the numerous duties concerning the channel repairs, and oversight.

The *phi* belonging to the *urfi* section have special privileges because they were the original builders/users of the channel. Besides the *sorogh* (daily allocation of water) and *charthtogh* (regular share of water to be discussed below), they also enjoy an additional two shares daily called *sawa*. The *urfi* will have priority over all others in case of water shortage. *Urfi* groups are also assigned easier tasks at the time of channel repairs, such as construction of walls, earth excavation and so on. Other groups are given the more difficult tasks such as cutting rocks and carrying stones. Various tasks from the headworks to the Bokhan Dur include repairs and oversight at the headworks. The *madok* and landslide prone areas are assigned to 7 *phi* comprising the following portions: *Urfi* section (4 *phi)*, Zang Lasht section (2 *phi*), and Macharagh section (1 *phi*). Thus the entire *phi* from the *urfi* section are involved every year, whereas the turns of each of the *phi* of Zang Lasht and Macharagh would reoccur every third and sixth year respectively.

For seasonal repairs of the remaining sections, 5 *phi* from Macharagh and 4 *phi* from Zang Lasht sections, are involved. For annual repairs or for emergency repairs, depending on the extent of the work, all of the sixteen *phi* are engaged.

Distribution of Water

The channel system serves both a large area and a large number of households; therefore, water availability to users is an important concern of the people of the region. To ensure reliable and equitable water supplies, specific rules for water allocation have been adopted. Different practises are applied which are derived from old established rights in accordance with specific inputs. Others are based on certain privileges enjoyed because of standing or merit.

Sorogh, Basi and Sawa

Sorogh literally means water per head or water allocated per irrigator. Water is allocated on the basis of two shares per *phi* daily to complete the turn in eight days irrespective of the number of families in each *phi*. Thus in all the water is divided into (16 x 2) thirty-two shares daily. The turn of water to each irrigator depends upon the number of families belonging to each *phi*. Those *phi* having more families have to wait longer until it is again their turn; this could be twenty days or more. The management of the *phi* share (*sorogh*) is delegated to the *phi* itself.

In certain cases, the *sorogh* is also called *basi* when the *soroghdar* (water shareholders) have to do night duty at the *madok* to ensure the proper supply of water in the channel for the next day. This type of *sorogh* or *basi* is always associated with another type of water share called *sawa,* which is given as a special privilege to the clans of the *urfi* portion because of their priority rights as original settlers. *Basi* and *sawa* run simultaneously, but unlike *basi* no night duty is done for *sawa.* But the interesting point regarding the two is that these are rotated between villages according to a set timetable. The two settlements where *sorogh* or *basi* is due, send two persons for night duty and at the same time, at some distant hamlet (always two in number), people of the same *phi* would be using *sawa* shares for irrigation. In this exercise, four settlements and four *phi* are involved at the same time. *Basi* and *sawa,* after rotating alternately from village to village, recur at the same two villages after ten or twelve days. The need for the additional *sawa* share arose when the number of households in the various *phi* of the *urfi* portion increased, enjoying the privileged status of original settlers. The villagers of the *urfi* portion have been able to allocate this additional share between themselves.

Charthtogh

Charth means a small opening and *charthtogh* means water coming through a small opening. There are 38 households in the area that are given rightful privilege of having a certain amount of water all the time. The amount of water is fixed according to three possible units, e.g. water equal to a horseshoe of about 10 centimetres diameter, a pony-shoe or 5 centimetres diameter and ass-shoe or 2.5 centimetres diameter. Some of these *charthtogh* are hereditary and belong to families descending from the founder clans. A number of *charthtogh* have been granted to certain families by various rulers during whose time the channel was extended. The possessors of *charthtogh* are called *charthtogh-dar.* Some of the *charthtogh-dar* are required to provide compensation for the *charthtogh,* by providing food at different occasions or by performing certain duties in connection with the maintenance of the channel. A number of them also provide wood for the sluice gates and their walls. The *charthtogh-dar* also include a few elites who pay nothing.

Tab. 5.2
Distribution of various types of *charthtogh* according to the different sections of the channel

Channel Sections	Number of *charthtogh*			Total
	Horse-shoe	Mule-shoe	Ass-shoe	
1. Urfi	12	5	0	17
2. Macharagh	3	7	1	11
3. Zang Lasht	0	11	0	11
Total	15	23	1	39

Tab 5.2 shows that people on the *urfi* section are in an advantageous position both in terms of the number and size of the *charthtogh* they are allocated, while the other section at the tail end are disadvantaged both in the number and units of *charthtogh* they are given.

Tab. 5.3
The number of households sharing the available *charthtogh*

Channel Section	Number of Households			Total No. Households	No. of *charthtogh*	Average No. of Households per *charthtogh*
	Horse-shoe	Mule-shoe	Ass-shoe			
Urfi	65	26	0	91	17	5.5
Macharagh	37	34	1	72	11	6.5
Zang Lasht	0	36	0	36	11	3.3
Total				199	39	5.3

The largest number of households that share the *charthtogh* are in the Urfi section because they are comprised of the old settlers (Tab. 5.3). As they are allocated more *charthtogh* of larger size, they have more water than *charthtogh-dar* of other sections.

Tab. 5.4
Distribution of *charthtogh* on a clan basis

Channel Section	Total No. *charthtogh*	No. of Ch.	Total No. Households	No. of Ch.	Total No. Households	No. of Ch.	Total No. of Households
			Baikey		Khoshey		Pathani
Urfi	17	5	29	5	47	7	15
Macharagh	11	2	25	6	18	3	29
Zang Lasht	11	2	2	5	18	4	16
Total	39	9	56	16	83	14	60

Tab. 5.4 reveals the following salient features: The Khoshey clan has the greatest number of *charthtogh*. This is because a large number of people in this clan were favourites of the rulers and were granted a number of *charthtogh* on an individual or family basis. The Pathani also have been allocated a large number of *charthtogh*. This is because a large number of *charthtogh-dar* included belong to important families who were close to the rulers. The Baikey have been at a political disadvantage over the last hundred years and did not receive any additional *charthtogh* in the extensions of the channel, as was the case with the other two clans. Most of their entitlements are in the Urfi section where they have a monopoly.

Tab. 5.5
Clans in terms of the units of the *charthtogh*

Clan	Horse-shoe	Mule-shoe	Ass-shoe	Total
Baikey	7	2	0	9
Khoshey	3	12	1	16
Pathani	5	9	0	14

Tab. 5.5 reveals that the Baikey have the largest number of *charthtogh* of horseshoe units out of which are five in the Urfi section. The Pathani also have a substantial number of both horseshoe and mule-shoe units because some members of the royal family and other notables are included in the clan who were granted the *charthtogh*.

Tab. 5.6
Distribution of the various units of *charthtogh* on a clan basis

class basis	Urfi Section		Macharagh Section		Zang Lasht		Total	
granted by	Ruler	Yuft*	Ruler	Yuft	Ruler	Yuft	Ruler	Yuft
Baikey	0	5	2	0	2	0	4	5
Khoshey	0	5	6	0	5	0	11	5
Pathani etc.	2	5	3	0	3	1	12	2

*Yuft means people.

Tab. 5.6 demonstrates that:

- Of the 39 *charthtogh* 27 or about 70 per cent were granted by the rulers.
- Of the 27 granted *charthtogh*, 21 have come from the channel extensions that were constructed by the rulers.
- Most of the granted *charthtogh* went to Pathani who included close relatives of the rulers or elites.
- Next to benefit from such a grant are the Khoshey who enjoyed an important status in the courts of the rulers.
- The Baikey have benefited least from such grants. Even the four *charthtogh* which were granted to them were in compensation for lands which were seized from them in Khot and were subsequently relocated in the Macharagh area.

One very important aspect of the *charthtogh* has to be highlighted, namely, the linkage between rights and duties which the *charthtogh-dar* are assigned and their share of water. It must be remembered that the *charthtogh-dar* have no share in *sorogh, basi* or *sawa* nor are they members of any *phi.* However, every *charthtogh-dar* is liable to contribute the services of one man, called *zhoitek,* to perform twelve hours duty at the *madok,* day or night, according to his turn, whenever required.

Moreover, with a few exceptions, the various *charthtogh-dar* will have to provide repayment for their privileges. Provision of three types of food, including *don, kali* and *shoshp kali* to people at the time of annual repair work could be one mode of payment. *Don* is bread: *chappatis* and *sanabachi* (a dish where sugar instead salt is added). With the exception of one *charthtogh-dar* who provides *don* annually, all of them provide *don* on alternate years. *Don* is provided to the *phi* members and the *merjoi* performing repair works near the house of the *charthtogh-dar.* The amount of food to be provided per head has to be scrupulously followed and includes four thick *chappatis* per head and one cup of *sanabachi* for four persons. For all this, upto 7 *maunds* (1 maund = 37 kilograms) of wheat flour and seven *seers* (1 seer = 0.9 kilograms) of ghee are used. Six *charthtogh-dar* provide *don.*

The other type of food provided is *kali,* a type of soup made of flour cooked in *ghee* and mixed with a lot of water. For this, three *maunds* of flour and about one *seer* of *ghee* is used. One *charthtogh-dar* is supposed to provide *kali* to feed 120 persons annually.

Shoshp kali is another type of food provided. It is a sort of liquid *halwa* which can be sipped but not eaten. It has a sweet taste and is made from fermented wheat flour. For this 3 *maunds* of wheat flour and some *ghee* is used. People do not like to eat *shoshp kali* these days, but nevertheless the *charthtogh-dar* has to provide it and is otherwise liable to be penalised. Only one *charthtogh-dar* provides *shoshp kali.*

Ra joi kali: At the time of the repair of the Urfi section of the channel the nearby villagers feed the workers a certain dish called *kali.* This custom has been adopted traditionally. This is in addition to the *kali* fed by one of the *charthtogh-dar.*

The other type of payments/compensations for the *charthtogh* made by the various people include providing wooden planks to be used for the *madok* or beams in the wall. Some of the *charthtogh-dars* are assigned to provide the cross-pieces (*ondoor-dar*), wood alternately used to support the *madok* whenever it is needed.

Tab. 5.7
The distribution of payments on a clan basis

	Urfi		Macharagh		Zang Lasht		Total	
	Plank	Crosswood	Plank	Crosswood	Plank	Crosswook	Plank	Crosswood
Baikey	2	1	1	0	0	0	3	1
Khoshey	2	1	6	0	1	2	9	3
Pathani	0	2	1	0	0	3	1	5

Tab. 5.7 suggests that the *charthtogh-dar* belonging to the Khoshey and Pathani clans share most of the payment in terms of planks or cross-wood for the channel. Six of the *charthtogh-dar* pay nothing except one *zoitek* (services of one labourer to work at the channel on turn) each. Out of these six *charthtogh-dar* one administers the *waqf* (trust) of the central mosque, three are notables and two are blacksmiths exempted for various reasons.

Additional Preferential Rights and Entitlements

After the annual repairs, the water is left at the disposal of the Baikey clan for one day. This is called *joi nigiali* (channel clearing bonus). Also, before the start of the rationing, water is left free for any body to use, this is called *harjalogh* (free for all).

Choghekan literally means stolen water. A lot of water is available in the Urfi sections of the channel and some people used to augment their *sorogh* through water theft. This practise continued for many years and was ultimately legalised in return for certain duties assigned to the beneficiaries. Generally such turns reoccur every ten days, their allocation and rotation being at the discretion of the *merjoi*. There are now twelve households in the Urfi section using such water.

Most areas towards the tail face a scarcity of water. The amount of water in the tail is insufficient for cultivation. In spite of the fact that their turn also reoccurs in approximately fifteen days, many such areas do not even get water for drinking and other domestic purposes. In view of such problems, a certain family in a village called *Khachomar* has been allocated very small amount of water humorously called *kalar nigini* (dead body washer).

Various Maintenance and Operational Tasks

The channel is opened at the end of May and closed at the end of October. Water discharge fluctuates according to the runoff in the stream. Fortunately, the flood period in the stream coincides with the cropping period and for most of the season there is no shortage of water.

To keep the channel operational, the following tasks are carried out every year at different times. During the winter snowfall and spring rains much damage occurs because of landslides, scree fall and avalanches. Before opening the channel, complete repair work is done. Moreover, considerable silt from the previous year also needs to be cleared. For all this work *kushun bolu* or people from the whole command area participate. These activities take almost a month to complete. Silt clearing is again done in July and August, an activity that is shared by the various *phi* as follows:

Urfi Portion: 7 *phi* (4 phi from Urfi + 2 *phi* from Macharagh + 1 *phi* from Zang Lasht)
Macharagh: 4 *phi*
Zang Lasht: 5 *phi*

During the summer flash floods, depending on the extent of the damages, either the *phi* members or *kushun bolu* (the whole command area) are called to work. In certain cases people from outside of the command area are also asked to help.

Fines/Compensations

Fines are levied for failure to perform one's respective duties on different sections of the channel. The fines may be in kind or cash depending on the nature of the fault. The fines are charged by the *merjoi*. Compensation is made in different forms, for example, compensation from *phi* members to *merjoi* is called *ishpan* and is given when certain member belonging to a *phi* instead of performing duties himself, pays a certain amount of money to the *merjoi*. This practise has lately been discontinued. Compensation can be paid by a member of a *phi* to its other members, for example, when a member of the *phi* pays a certain amount of money as *ishpan* to fellow members to assume his duties.

CONFLICT

Not many conflicts occur between the irrigators. In a few instances there have been conflicts between the irrigators at the tail end and those at the middle and upper portions, but these are regularly settled by the *merjoi*. The system of *merjoi* is so strong that many such matters are easily settled by him or with the counsel of village elders. Co-operation rather than conflict tends to be the norm with respect to irrigation in the Khot system. This is in no small part a function of the necessity to work together for survival in a cataclysmic and ever changing environment. Similar patterns have been documented in the crisis-prone areas of Nepal and the mountainous irrigation systems of other parts in the world.

CONCLUSION

The study leads to following conclusions:

- The organization at Khot is an old one and has developed through many centuries. Time for development has thus been an important key to successful organization for irrigation management.
- Water, land, history and destiny of people of the region have been intricately bound.
- The role of traditional ruling institutions has been significant in the development of the irrigation network as well as in its operation and maintenance.
- The successful strategy in the region has been participation of the local people in channel construction activities, and upon project completion the irrigators assumed the responsibility for system operation and maintenance.
- Farmers of the study area are quite capable of creating and maintaining their organization for irrigation management and of managing water in ways that is adapted to their environment.
- The role of channel chief has been another important factor. Besides belonging to the community, he should also possess some political authority to assert himself for the implementation of the rules and regulations of the organization.
- Socio-demographic phenomena, especially clan spirits, heterogeneity and homogeneity of the people also play an important role in the success, or otherwise, failure of the systems.
- Outside interventions are welcome in the area but the people would like to be taken into confidence before such interventions are affected.

Valuing water as a "community property" can become an organizing and unifying force for farmers in a given system. The success of the Khot system also lies in the fact that its organization is totally based on community decisions. Management and decisions related to irrigation are based on the premise that water is "community property".

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6

Irrigation Practice in Yasin, Northern Areas of Pakistan

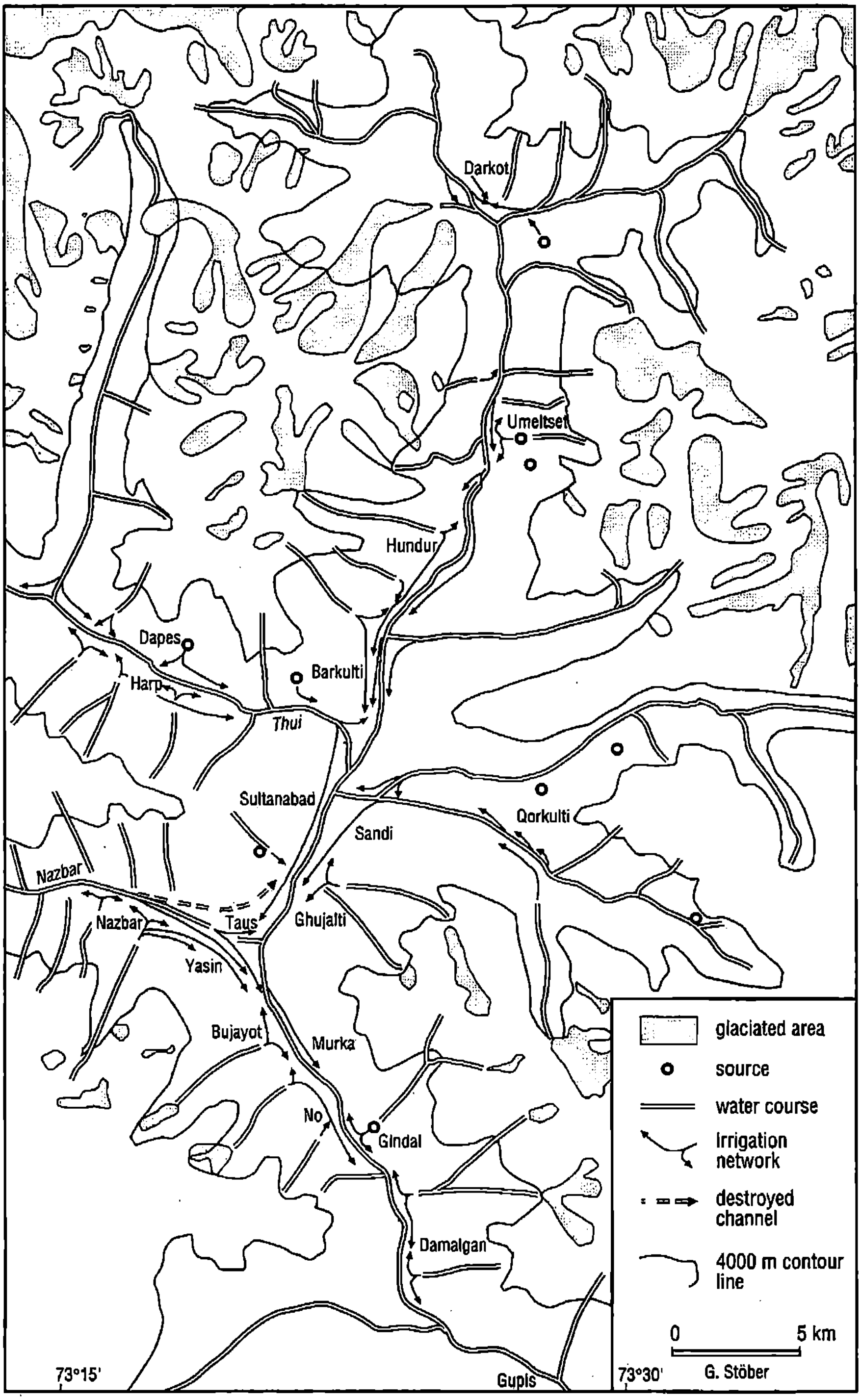
Georg Stöber

One of the major concerns in an arid environment is the water supply for field crops. Bringing water to the fields through an irrigation network involves not only construction of the network, but also requires the development of procedures for on-going maintenance, for the organization of the distribution of the water and for coping with network disruptions. In many cases such tasks go beyond the potential of the individual cultivator and instead are socially regulated and carried out as a group effort on a scale which could vary from the level of the individual family up to "the state" itself. Irrigated agriculture has been differentiated by technology applied as well as to differences in the physical environment which determines the source and amount of water available for crop production. The socio-political structure of the concerned societies is also a relevant factor. Therefore, general statements should be avoided in trying to assess the general management structure of irrigation systems.

Here, instead, a sketch of the irrigation system of Yasin, a valley in the Northern Areas of Pakistan, will be presented as a case study.[1] In this discussion, we will:

- explore the social units involved in the different aspects of irrigation,
- appraise the extent of variability of this involvement in space and time (as the society is under transformation), and
- analyse the causes of this variability.

The area covered in this case study, Yasin (Fig. 6.1), is a side valley of the Gilgit/Ghizr River as well as an administrative division (*tahsil*) of the Northern Areas of Pakistan. It is situated 80 kilometres north-west from



Topographical source: India and Pakistan 1 : 250 000, Serie U 502, Sheet NJ 43-13 (Mastuj) and Sheet NJ 43-14 (Baltit)

Figure 6.1: Irrigation networks in Yasin.

Gilgit town. The main valley runs for 50 kilometres from north to south, but major tributaries (Thui, Nazbar, and Asumbar) follow a west to east or an east to west direction. These rivers are fed by the melting waters of snow and glaciers. The accumulated snow and ice mass, and therefore the discharge, is low in relation to the central and eastern parts of the Karakoram, especially in the southern parts of the drainage area which are of moderate altitude. Only a small area reaches the level of highest precipitation, at approximately 5000 metres.[2]

Despite high precipitation at higher altitudes, the main valley floor, lying between 2160 metres at the mouth of the Yasin River and 2710 metres at Darkot, as well as those of the tributaries and the lower parts of the slopes, are characterized by arid conditions. Here annual precipitation may only slightly exceed 100 mm. Therefore, the main settlements, situated on sediment fans of minor streams or terraces, depend on irrigation for agriculture.

In 1990, the population of Yasin consisted of more than 25,000 inhabitants living in approximately 3000 households. The inhabitants are of different origin which can often be traced through oral traditions of immigration. Many of these chronologies date back to immigration events occurring several generations ago, but some are of more recent times. The language situation reflects this heterogeneity. The majority speaks Burushaski, including assimilated former immigrants, but Khowar is the language of the former nobility and six other languages are spoken by a small number of people. As Burushaski and Khowar speakers do intermarry, several families are bilingual with their members having different mother tongues.

The average household size is 8.7, but the range of family size can be quite wide, with households reaching up to thirty members and more in the extreme. These large households consist of joint nuclear families of several brothers and sometimes cousins who combine their economic activities and resources instead of separating and building their own houses. The growing importance of monetary income, however, has increased the tendency for splitting up these large households. Households that separate divide their fields and—apart from the youngest brother and his family who inherits the old house (*ha*)—construct new homes. This is done on the family's land, generally in the vicinity of the old building. By this means, clusters of houses (*deh* = village) come into existence, which are generally inhabited by related families of joint patrilateral descent, that is by people of the same *qom*. Several such *deh* form villages with officially recognized names. In larger villages, a number of households beyond the *qom* cluster but below the village level combine to form a neighbourhood, generally called a *giram*, which has predominantly a social and/or ritual function, as during marriages or burials.[3]

The villages of Yasin were under a *lambardar*, a functionary of the Yasin *raja*, who was the head of this former principality up to 1972, when traditional rule was abolished. In the 1980s, village organizations were founded as a form of self-government, stimulated by the activities of the Aga Khan Rural Support Program (AKRSP), a development agency (NGO) with Ismaili background.[4] Its involvement has been successful largely because the majority of the Yasin population belongs to the Ismaili faith and the Ismaili community is strongly organized. For the purpose of handling communal affairs, Yasin has been divided into three groups of villages or local councils: Yasin proper from the south to the centre; Selgan from the centre to the north and the Thui valley. There is also a strong minority composed of Sunnites in the area and a smaller minority of Shiite Muslims.

As to state administration, the villagers elect members to Yasin's Union Councils. Yasin is also represented in the District Council, and the Gupis-Yasin Subdivision is entitled to one seat in the Northern Areas Council, the highest representative assembly of the Northern Areas. Executive power in the Yasin *tahsil* is in the hands of a police officer *(thanadar)*, and a civil administrator *(tahsildar)*, both stationed at Yasin village.

The old *raja* today occupies an unofficial but influential position and, for some years, he was the elected member to the Northern Areas Council, until he had to give up his seat to a member of the former religious elite. All these levels of organization fulfil certain functions and will be mentioned in connection with irrigation.

Agriculture is the dominant economic activity of nearly all Yasini households, but it has to be supplemented through migrant labour and other sources of income. The form of agriculture practised in the area has been characterized as "arid mountain agriculture" (Staley 1966). Farm sizes are limited, with most of the households having less than one hectare, even if their fields in other main or summer villages are included. The cultivation of fieldcrops (at present wheat, maize, some barley, millet, legumes, several vegetables) and fruit trees (predominantly apricots) are supplemented by animal husbandry (sheep and goats, cows, sometimes yaks). The fertility of the soil depends on the manure of these animals as they themselves rely on the harvest for winter fodder. During summertime, from the end of June onwards, most of the animals are transferred to summer pastures (*ter)*, high up in the mountains. Up to 3500 metres, summer settlements with barley cultivation add arable acreage to the village farms. At even higher altitudes the activities are restricted to pastoralism.

Not every household sends members to the summer pastures. Some families lack land and a house in the summer settlements. Others cannot spare members for this work or they may even decide to stay at home because of comfort. Such individuals send their animals with relatives or keep them at home if their number is small. Animals return to the main villages at the end of September or sometimes later, when after the conclusion of harvest the agricultural year—that starts at the beginning of March with the enclosure of the fields[5]—comes to an end.

All cultivation, in the main valley as at the summer settlements, is dependent on irrigation. Unirrigated crops are not to be found in Yasin. Water is mostly diverted from ravines or side valleys above the settlements and fields without much construction work (see Fig. 6.1). Here often a mere ditch in the gravel bed will suffice. On the other hand, where canals branch off the main rivers, solid canal headworks have to be built that enable them to divert water to the canal when the river is low, yet also allow them to reduce the size of the inlet at the time of high water. Generally these works suffer from the floods during summertime and have to be repaired or sometimes reconstructed year by year. To reduce this damage, the stone weirs are now being covered with wire netting to fix the gravel in its proper place.

Generally the water is channelled through wasteland for some distance before reaching the fields with an inclination less than that of the river course. If it is a main canal, it may be split into several branches to serve different areas of village lands, and some large canals are used to water more than one village. In case of small watercourses, on the other hand, the water may be stored overnight in a tank to allow it to be distributed during the daylight hours. The structure of the outlets allow control of the rate of water flow from the primary canal *(dala)* into the secondary canals. In larger canals, these outlets *(il)*, often consist of stonework or flagstones of schist perforated by a hole of approximately 10 cm in diameter that may be closed by stones and bunches of grass. Sometimes a system of secondary canals may be able to receive water through more than one outlet, but only one has to be opened at a time. The secondary canals bifurcate into various arms which can be closed by a shovel of soil as necessary; each leads water to several fields. According to the inclination of a field, irrigation furrows of different arrangements regulate the rate of the flow at the watering to try to minimize erosion. Excess water that has been run through an irrigated field is drained through the lower part of the secondary canals. This water runs into a lower primary canal[6] or the canals terminate at the edge of the cultivated area, above the stream where excess water discharges into the river.

Generally, a canal is fed only through a single watercourse, but sometimes more complex systems have been constructed in order to cope with the limited water supply of some rivers by allowing them to tap more than one source as necessary. One example of this can be found at Ghujalti, a village on a sediment fan on the eastern bank of the central Yasin valley (see Fig. 6.2). The lower parts of the village get some of their water from the Qorqulti River through two canals extending southwards from the

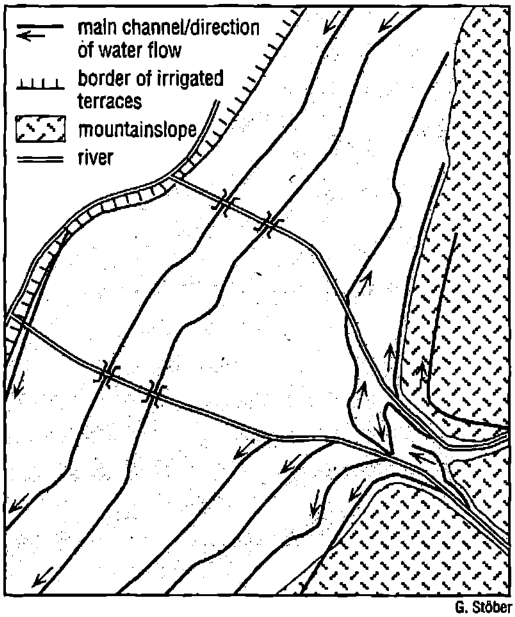

main channel/direction of water flow
border of irrigated terraces
mountainslope
river
G. Stöber

Figure 6.2: Water management in Ghujalti

neighbouring village, Sandi. This water supply, however, is insufficient during the growing season when the water demand of Sandi village increases and has to be supplemented by water from upper Ghujalti where the water of two small streams—the Haltar and Hisikbar—is used. As the Hisikbar is fed by the melting water of snowfields, the Haltar by a small glacier at higher altitudes whose melting sets in at a later date, the two watercourses do not provide water at the same time. Water is taken from the Hisikbar at the beginning of the irrigation period in April, whereas the bed of the Haltar is dry at this time. The water flow of the Haltar begins to be more than negligible about the middle of July. As a consequence, the Hisik water has to be distributed into all the canals of Ghujalti at the beginning. This is achieved by transferring some of the water via a canal to the bed of the Haltar. Later in the season, the direction of transfer changes and the Haltar water flows through a second canal into the Hisik. Since the highest canal dividing Hisik water for irrigation branches off that watercourse above the mouth of the Haltar-Hisik transfer canal, the neighbours have to use Hisik water during the entire irrigation period. In summer, the quantity of water from the Hisik is so low, that neighbours of that canal have to go to the Yasin River for their drinking water, as all inhabitants have to do during wintertime when both tributaries are dry. The type of complex canal system just described is scarce in Yasin notwithstanding that several villages use water diverted from more than one river for different parts of their fields.

The canal systems vary by size. Even if the canals in Yasin are not as long as those in Hunza they are still sizeable, with the longest primary canals running for ten kilometres or more and serving more than 150 households each. At the other extreme, there are also small private canals used by a single household.

The conditions under which these canals were constructed vary widely. Several are of recent origin, but most are quite old, some with later enlargement and modifications. Canals whose construction is remembered in oral history date from the last quarter of the nineteenth century onwards.

Their genesis follows different patterns. In former times construction required the consent of the ruler. In most of the cases farmers or settlers seem to have asked for land. When uncultivated ground was allotted, these farmers had to construct the irrigation system by themselves. Sometimes the building of a new canal was initiated and organized by a local notable, e.g., a member of the religious elite or a *lambardar*.

When the rule of the *raja* ended in 1972, some individual families constructed new canals which generally irrigate only small patches of land, sometimes hiring wage labourers, e.g., Gujur immigrants to do the manual labour. One canal was constructed by the state to serve a power plant, but it was put into use for irrigation, too. Another canal was built with some public help, but most new canals were constructed by village communities (village organizations) with the financial and technical support of the AKRSP.[7] Altogether these activities were of limited importance in Yasin and fit into the usual pattern.

One special case only does not fit into this general scheme. Here the ruler was more than usually engaged in construction work. Raja Shah Abdur Rahman Khan who was installed twice as governor of Yasin, from 1895 to 1911 and from 1923 to 1933, is given credit for having brought the Taus plain, a vast terrace in central Yasin, under cultivation after a period of abandonment. The initiative for this project, however, goes back to the British colonial administration and their Political Agent. After the Chitral campaign of 1895, the high garrison costs at the Gilgit Agency were felt as a heavy burden. An attempt was made to reduce the amount of supplies that had to be imported from Kashmir by purchasing local products. To increase cereal production, new canals had to be constructed to bring wasteland under cultivation. A small unit of sappers and miners was formed in 1895 to support local inhabitants in carrying out this work in various parts of the Agency. At the beginning of 1896 the cultivation of the Taus plain was planned. Work on the canal branching off the Thui River started in 1898, in the beginning under direct British control. In the following years, the governor (*raja*) safeguarded continued work by means of forced labour in spite of some resistance by the inhabitants. Construction work was interrupted for several years, but was finally successfully accomplished when in 1928 a first canal was put through. A second functioning canal is mentioned in 1931 and the allocation of plots below a newly constructed canal started in 1938.[8]

In fact only the upper one of two other canals reaching Taus was newly constructed for its total length (this one happened to be relatively narrow, but was widened in 1984). The other canal was an extension of a pre-existing canal, which lead to a neighbouring village. In the meantime, in addition to the Thui valley canals, two additional canals were constructed deriving from Nazbar. In order to allow the irrigation of the highest cultivable parts of the Taus plain, a third canal from Nazbar was built between 1964 and 1976 by a contractor as a public enterprise. This canal branches off the river approximately 7 kilometres upstream. The canal was highly susceptible to damage (e.g. through rock-falls) and required frequent maintenance as its course crosses numerous debris slopes and steep grooves. Consequently it was abandoned after two years of operation, as were the newly cultivated fields.

The Taus case marks one extreme in the spectrum of canal building organization: the involvement of "the state", incarnated in former times in the person of the local ruler, nowadays carried out through governmental authorities and their regional offices (e.g. NAPWD, Northern Areas Public Work Department). Work itself was carried out through forced or wage labour. At a lower institutional level, one that seems to dominate, the community, e.g. a group of farmers of a village, or the households of one or two village organizations, act on their own behalf with organizational support from a village notable (*lambardar*), or today, with financial and technical aid of a developmental agency (AKRSP) as mentioned above. Finally, at the lowest institutional end of the spectrum the individual farmer acts on his own behalf, sometimes with some help of neighbours or paid labourers. Whereas those projects are more numerous, they are of minor scale and the constructions add a number of fields to pre-existing villages only. The completion of the Taus canals on the other hand rendered possible the founding of a large village. Therefore this case was described more in detail.

Once in use, canals have to be cleaned and repaired regularly. Cleaning is especially necessary where a river (especially the Thui river during summer) transports a large amount of suspended silt which is deposited where the velocity of the flow diminishes such as in an irrigation canal. To avoid freezing, most of the canals do not carry water during winter, from November to April, and cleaning is done in spring before labour in the fields begins and the demand for irrigation water starts.[9]

In principle, every farmer is responsible for cleaning the area of canal bordering on his property. Each farmer has to do this on time, i.e., before the water will be released, or it will not run smoothly and the canal could overflow and damage the fields. Therefore no formal sanctions are necessary. As most canals run through stretches of uncultivated grounds, combined efforts have to be organized to maintain these areas as well as the canal headworks.[10] The timing of this work, as well as of the individual cleanings, needs some organization especially when activities of several settlements must be co-ordinated. The methods of organization vary widely through the area and sometimes changed during time.

Photo 6.1: Channel head: Irrigation water diverted from the Thui River in spring (March). Because of very low water levels during winter and spring a dam is constructed for the diversion of a certain quantity of water. The channel presented here serves a water mill, the majority of channels are kept dry during this season (Georg Stöber 1990).

Photo 6.2: Channel head: Irrigation water diverted from the Thui River in mid-summer (August). Glacier melt has turned the Thui River into a stream carrying enormous quantities of suspended matter. Only huge boulders withstand the force of the current and protect channel heads from being washed away. The construction serves the task to provide a certain quantity of irrigation water and at the same time to protect the channel from overflow which could cause damage further down by limiting the supply (Georg Stöber 1990).

Today, most villages decide upon the dates at a meeting of the village organization. Sometimes elders contact the concerned neighbouring villages. In other villages, special meetings of the village households or the neighbours of special canals are called in to arrange irrigation matters, the cleaning as well as other duties of mutual concern. Some villages which hold special irrigation meetings formerly use the meetings of the village organizations for these matters today. Moreover, in some smaller villages no meetings take place. The dates are fixed and made public during informal conversations. Sometimes elder members of the community feel responsible for arranging these discussions. In some cases in the past, a *lambardar* initiated the canal cleaning although this was not one of the common duties of a *lambardar*. Today the office is without any official function, but some of these former office holders continue their activities as in Manich or Taus.

The real organizational duties are sometimes carried out by a special functionary, the *asaqal*, who is obliged to call the users of a canal to any cleaning or repair work in spring, to have built dams through the river when the water level is low during springtime and autumn, and to control the utilization of irrigation water. He has to give notice to all the participants of a working campaign personally. He will not get any special allowance, but is entitled to stay away from work. An *asaqal* who is responsible for just one canal is elected by the canal users for an indefinite period, but is subject to dismissal if he is not felt to be properly carrying out his work. It should be mentioned that sixty years ago an *asaqal* held a position equal to that of a *lambardar* of later years. At that time, the office had no special relationship to irrigation.[11]

In 1990, only four villages, all situated in central Yasin, had one or more *asaqals*, (namely Ghujalti, Sultanabad, Taus, and Yasin village). Here the irrigation system is complex, but there is no *asaqal* found in other equally complex situations (such as at Barkulti). The persistence of this function may reflect the spatial positioning of the former villages, near to the political centre of Yasin where traditions of the old power structure may have survived. In other areas, the *asaqal* system fell out of use after the removal of the *raja*, and in some peripheral villages at the upper Thui valley all formal institutions regarding irrigation are missing. It should also be mentioned that the villagers regard the amount of water available for irrigation to be a crucial factor in institutional arrangement, since they feel that methods of control are only necessary where the resources are scarce. At Darkot, for example, the office of an *asaqal* (and that of a *dalakuin*) is said to have been abolished when the canals were enlarged. Nevertheless, this is not an overall explanation, as such office holders also seem to be equally non-existent in villages with scarce water resources in southern Yasin.

After canal cleaning water will be released at a fixed date. At Ghujalti, this is said to be done in a traditional way. People assemble near the canal head bringing foodstuff, traditional home made meals or bought food, for feasting. After the meal a *fatakin*, a descendant of the first settlers of the place, releases water into the canal. According to local custom his efforts are required as a precondition for good prospects. Thereafter the community decides on the rotation of irrigation. Ghujalti, however, is an exception. Most villages settle these irrigation matters at the earlier mentioned meetings. At this occasion, too, another functionary, the *dalakuin*, is appointed for the period of one year in one third of the villages, in cases where the canals are longer and wider than usual. Each *dalakuin* is responsible for a single canal and has to regulate its water intake, to reduce it in the evening and to reopen it early in the morning. On canals without an *asaqal*, the *dalakuin* has to carry out some of those duties, too. The job is labour-intensive and does not increase one's social status, but it may be of interest for a person with limited resources, as the *dalakuin* gets an allowance from the canal users of one kilogram of grain per field (at Barkulti) or two kilograms per household (at Sandi). If the users do not appoint a *dalakuin*, a system may be established where the first user of the day may open the canal and the last one close it in the evening, or the water may not be controlled at all.

In the division of irrigation water one has to distinguish between the distribution among groups of households (settlements, quarters, or irrigation groups) and the internal division within these groups. The customary regulations vary widely, as they are dependent on the water supply in relation to the number of users. The less water available for irrigation becomes the more complex become the distribution systems. This holds true seasonally as well as regionally. In cases where the amount of water is highly variable in relation to the demand throughout the year, different regulations may be applied during the year even within the same village.

When the discharge of a river or spring is low, water may not be diverted to all branching canals at the same time, but rather will be rotated to only some of them for one or two days at a time. Such regulations are found especially in the Thui valley. Where long canals exist but the rate of flow is low, water is divided between different sections of the canal, such as an upper and a lower section, serving different parts of the village or sometimes different villages. In the most usual pattern, one section might get water at the first half of the day, while the other section gets it during the second half of the day. In some of the systems of Yasin no internal distribution is implemented and the individual farmer may take water as required, even if such rotations between canals or sections are practiced. In other cases the rotation of users is fixed at the aforementioned meetings before or after the cleaning. In addition, there is variation in individual water rights, where sometimes the title to water correlates with the title to the land, yet in other places, every household in the community is entitled to the same period of water use.

Two examples shall illustrate the fact that those regulations may differ within a single village as well as seasonally. The village of Barkulti gets irrigation water from Hundur via Sheyghatan, from the Tselpebar near Barkulti, from the Darkot as well as from the Thui River. One of the two canals from Hundur serves Barkulti the whole day; every user gets water once every seven days. The second canal brings water to Sheyghatan and Barkulti in the forenoon only. The users of Barkulti follow a rotation period of five days. The users of both canals decide on the rotation at a yearly meeting. The water of the Tselpebar is conveyed to a northern and into a southern canal every other day. During night-time it is collected in a tank and diverted through other canals during the day. Every user gets his water once a week.

The regulations of the canals which branch off the main river differ according to canal section. The lower of the two canals serves the upper section in the afternoon, and no further rules are applied to the individual use. The users of the lower part of that canal on the other hand will get water every two or three days in the morning. The second canal was built in a first section during the first third of this century. Here, no rules regulate the distribution. A certain amount of water, one *il*, is left to the neighbours of a later extension of the canal, who are entitled to take water every two or three days. The canal branching off the Thui River was enlarged some years ago, so that all of its three branches divert water the whole day without any regulations. One of these branches is used by a mill, one by three families of a special *qom*, and the third by a religious and political notable (*pir*) of Barandas. Despite the limited number of, influential, beneficiaries the enlargement was carried out as a project of the village organization with the support of the AKRSP. This example illustrates that besides the water available for irrigation, titles resulting from the genesis of a canal influence the distribution of water in the system, even if this can be demonstrated by only a limited number of more recent examples.

The second example, Ghujalti, whose canal system was introduced above (see Fig. 6.2.), on the other hand, demonstrates water distribution in case of seasonal shortages. Between plowing and the germination of seeds, the amount of water required is limited and can be entirely met by the Hisikbar and, at the lower parts of the village, by the canals from the neighbouring village, Sandi. When the demand rises in the month of May—in Sandi as in Ghujalti—water has to be rationed until its level rises in the Haltarbar around the middle of June. Water has to be assigned to the different parts of Ghujalti successively. Every farmer is said to be entitled to only irrigate a single field during each rotation period. A second field could be watered during the next rotation period and so on. From the middle of June onwards all parts of Ghujalti will receive water at the same time. At Ghujalti proper water is distributed between ten irrigation groups of nine households each. Every group is entitled to use all the water in the canals of this part for one day (and one night) in turn. Generally several of the households, all of which can lay claim to the same amount of water, are able to irrigate at the same time. When the water is insufficient, a fixed rotation is observed. There are only ten to fifteen households in the remaining parts of the village; these are not divided into special irrigation groups.

As was indicated above, the regulation of water distribution depends not only on the quantity of water available, but also on the distribution of titles. On canals that belong to one family or to only a few households, and which irrigate only small plots, complex distribution systems are superfluous. Only a regulation forbidding flooding of fields in case of water shortage may be necessary.

Complex systems on the other hand are to be found where a large number of households of several villages are served. If the capacity of such a canal is large enough, the division of the canal into several sections, as described for Barkulti, may be unnecessary in spite of other regulations. The two Taus canals discussed above are an example for this kind of water management. Here, water is divided between several groups of households all of which are permanently entitled to take a fixed amount of water. Within the groups, the water has to be divided according to the diverging claims on a rotational basis. The unit for division is the *il*, the standard outlet of the main canal (see above). The water flow of a canal can be quantified by the number of *il* opened simultaneously. This term defines the title of a corresponding water use as well. In the case of the Taus canals, the upper one serves the village of Sultanabad with 9 *il*, the lower with 13. Water and land titles correspond to each other. In former times, a household cultivating a defined section of arable land seems to have been entitled to one *il*. Subsequent division of households and the fragmentation caused by the buying and selling of land have also fragmented this water allotment; now requiring the further division of one-*il*-shares. Those households that divide one *il* of water between them also do it by means of rotation. During a cycle, *nabat*, of five or ten days, each household gets water for a fixed period, generally measured by days or half-days. This is used according to the requirements of the crops. The *nabat* system starts with the fourth irrigation of a field. The first three waterings are exempted as young plants have only low water demands.

In the village of Taus, property has not yet been highly fragmented, as in many cases the heads of the present day households often settled with their parents in Taus when land was distributed after the completion of the canals. Nevertheless, the situation is more complex as canals branch off. Taus gets a share of 12 *il* from the lower Taus canal. This water is divided into three branches of twenty-four households each getting water for one day in turn.

The upper Taus canal divides into four branches. One of these canals belongs entirely to the family of a former governor of Yasin which possesses extensive property in Taus. The water of the three other canals is divided between six irrigation groups of twelve households each. Each household receives water every six days for half a day. Household division or the selling of fields would lead to a further fragmentation of these water shares.

The example of Sultanabad/Taus as well as those of Barkulti or Ghujalti indicate some of the factors responsible for the variability of regulations: the amount of water available, the capacity of a canal in relation to the acreage cultivated, the number of users, and the water right titles resulting for example from a family's historic participation in canal construction. Highly formalized rules are to be expected where a large number of settlers of mixed origin are brought together under a centralized settlement scheme. Nevertheless, canals constructed by small groups of people do not exhibit conformity, but are managed by a variety of regulations. On the other hand, the complexity of these distribution systems is low compared to those of central Hunza (see Chapter 7). Seasonal water shortage combined with a large number of users per canal are far more pronounced in Hunza than in Yasin, where only relatively small settlements are to be found in regions of acute water shortage, especially in southern Yasin.

People try to handle the regular seasonal water shortage through complex canal systems and distribution schemes. Distribution cycles, however, are no means to cope with unexpected events which stop the water flow and interrupt irrigation. This may endanger the ripening of the crops if the water flow is not restored quickly. Events such as landslides or mudflows can result from heavy melting or torrential rains. Generally, the repair of canals is the responsibility of those who clean them, that is, the owners of the land neighbouring the canal on cultivated grounds. In case of heavy destruction, however, this is not a reasonable way to solve such massive problems as during the time it would take for a single household or a group of neighbours to make repairs the crop would be damaged. When the canal affected serves several villages, the danger of crop failure becomes threatening, but such cases are exceptional and so far have been managed without a special set of rules.

One example shall illustrate such an event. In the night of 26th/27th June 1990, a torrential rain fell on parts of Yasin during a thunderstorm, resulting in mudflows originating in the relics of the lateral moraines existing here and there along the slopes above the Yasin villages. The village of Sultanabad was especially affected by these mudflows. Apart from some destroyed farmsteads and various submerged fields and roads, the mud flows affected the two Taus canals at several points, filling them with boulders, stones, and mud along a distance of from one to one and a half kilometres. As the water flow was totally interrupted, more than 350 households suffered from the canal blocking; not only the village of Sultanabad was affected but Taus, too. Because all the cleaning, the digging out of the heavy liquid mud (which becomes a sun-baked cement as it dries) and the breaking of the boulders had to be done by hand, the work was far beyond the capacity of the neighbouring inhabitants of Sultanabad to carry out within a reasonable amount of time.

The morning after this disastrous event, the *tahsil* administration in Yasin village was informed. The *tahsildar* as well as the *thanadar* visited the place some hours later to inspect the damage and promised immediate help. Meanwhile, the president of the village organization of Sultanabad asked for the support of other village organizations. In the neighboring villages, these requests were made public at the prayer times at the *jama'at khana*s and mosques. The respective members of Union Council, the official political representatives, organized the supporting activities. They recruited working groups to go to help Sultanabad with shovels and pickaxes on subsequent days and arrange for a system which would enable the work to be effectively shared. Another "institution", the former *raja* and late member of Northern Areas Council, Ghulam Dastgir, involved himself in this matter by inspecting the restoration work and by having the labourers entertained by a group of musicians he paid out of his own pocket. Through these acts, he might have hoped to improve his political (even if informal) position.

Though Sultanabad got support from many volunteers, these and the official "inspectors" had to be fed in exchange, an expensive enterprise and a hard work for the women who had to prepare the meals. In this, the *giram* group co-operated. Every *giram* took care of the workers on its own canal section.[12] As the result of all these efforts, the water flow was resumed after five days on the lower Taus canal and after six days on the upper. Though irrigation continued at once where the rotation cycle was interrupted, even this relatively short period of water deficiency let to a marked decrease in production.

To manage the crisis all institutional levels available had been involved: the civil and police administration, the official local representatives, the unofficial local (village) organizations and their elected representatives, as well as the religious communication networks and the traditional neighbourhood, not to mention the traditional political head pursuing his own interests. This was, however, an uncommon event, and the quick and extensive management of the crisis may be related to the large number of people affected. In other similar incidents, for example a mudflow that destroyed a considerable part of Darkot village in 1978, no public support was given.[13] In this case three canals had to be constructed anew in a short time in order to safeguard the maturing crop.[14] Standardized solutions to problems of irrigation management are to be found only in "normal" and "regular" situations, but the capacity of the people affected to mobilize support by other socio-political institutions is crucial for the management of exceptional circumstances.

In "normal" situations, however, it is the household which can be considered the smallest unit in the social organization of irrigation. It is the household that possesses the title to irrigation water in a defined way and may therefore be the unit of rotation in a system of water use. Moreover, the household, not a special person, is obliged to participate in joint activities.

Above the household level one cannot postulate a universal irrigation structure as Yasin's irrigation systems vary so greatly. Taken together, all aspects of irrigation discussed exhibit a significant variety of arrangements. Specialized functionaries exist only on a limited scale. To a high degree, it is the informal contacts or multi-functional village organizations or institutions which are employed to manage irrigation affairs. Today there is even a tendency to reduce further *institutional* efforts at the local-level as the abolishing of the roles of the *asaqal* or *dalakuin* indicate. Canal construction also differs in scale depending on the project and its organizing agency, from state to private enterprise; organization of the maintenance of a canal can vary from informal accords to a formally discussed or ordered group effort; and regulations of water use from unrestricted taking to well defined titles and rotation systems.

The reasons for this diversity are manifold. The amount and seasonal distribution of melting water in relation to the demand, the size and construction history of a canal, the extent of political control over village matters are only some of the crucial factors. These examples illustrate the danger of generalizing from isolated cases without fully analysing the constituent elements involved in each system; these case studies demonstrate also that in spite of the importance of irrigation to the region, specialized institutions and offices are not an indispensable prerequisite for the functioning of the system in this mountainous environment. (Where they occur they seem to be connected with a higher degree of central political control). Village communities are able to manage their own irrigation systems on their own behalf. Disputes inside or between villages which will arise will have to be settled, but for that purpose no governmental authorities are required. On the other hand, canal construction projects of a considerable size go beyond the means of the village community, as they cannot be built by those alone who will profit from the work. Here only the extensive employment of forced or wage labour proved to be practicable requiring a strong political authority or financial backing from an institution of a higher than village level. Whereas formerly the maintenance of those canals was transferred to the users' communities, the same does not seem to work today as in those few cases of publicly built canals maintenance rests in the hands of a board (because the canals serve power plants) or the canal declined. Taking into account the financial and technical support of other projects, too, the state and foreign-based institutions add a new element into Yasin's irrigation systems: the growing dependence on external inputs. This recent development is not unique for irrigation but characteristic for the whole economy.

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NOTES

1. The fieldwork was carried out in 1990 and 1991 as a part of the "Culture Area Karakoram Project" sponsored by the German Research Council (*Deutsche Forschungsgemeinschaft*). My thanks go to the institutions involved, my colleagues and, first of all, to the friends in Yasin who made this research possible. I have to thank Dr Kreutzmann for his remarks on a first draft of this paper and Dr Manzardo for his stylistic modifications.
2. Owen and Derbyshire (1989: 34) estimate the precipitation at altitudes of above 4500 m at 2000 mm, Hewitt (1989: 14) values it at 1000–1800 mm between 5000 and 7000 m altitude in the central Karakoram.
3. In former times the members of the *giram* combined their labor capacity to bring the manure to the fields, a practice coming out of use gradually. Nowadays this work is generally done by the members of the individual households.
4. Other organizations, too, have implemented development projects in Yasin, such as the FAO or the governmental Northern Areas Public Work Department.
5. Animals and the public have open access to the fields from after harvest to the beginning of cultivation work in spring.
6. Apart from irrigation requirements canal water is used for drinking and household purposes, this unsanitary practice has negative consequences on village health.
7. Cf. for AKRSP's development strategies in the field of water management the article by Khan and Hunzai in this volume.

8. *See*, India Office Records files IOL/PS/7/84; IOL/PS/7/85:808f; IOL/PS/7/110:1155; IOL/PS/7/111:170; IOL/PS/7/226:437; IOL/PS/7/240:948; IOL/PS/10/826; IOL/PS/12/3288.
9. Where plowing is done without previously watering the fields, sowing may precede canal cleaning, which essentially means the digging out of silt deposits.
10. A participant who misses this teamwork generally will not have to meet severe sanctions. Sometimes he may have to pay a monetary fine or, in former times, a goat, as in Manich.
11. *See*, Lorimer manuscripts at SOAS, London, file MS 181247 / II (Kh.) H+J: 293 f.
12. E.g. one *giram* had to prepare meals for approximately 300 people on one day only. So during the reparation work 80 kg of rice, 2 kg of tea, 3 kg of sugar, 10 kg of ghee, etc. were consumed at costs of Rupees 1500 to 2000. Some financial help was promised by the district. Most of the money had to be collected by the *giram* members. In addition, official guests like the *raja* and his following who had to be entertained in an appropriate manner (meals with meat etc.), were received by one of the households which had to bear the costs by its own.
13. Apart from the distribution of one blanket per family by the state.
14. Additionally many households had to rebuild their destroyed houses before winter. In this enterprise, no public support was given. Every household had to rely on its own labour force.

7

Water Management in Mountain Oases of the Karakoram[1]

Hermann Kreutzmann

INTRODUCTION

In recent years development planners have been focussing on the expansion of irrigated lands in order to safeguard the nutritional basis for a growing population. In the rural areas of the subtropical belts extending the potential growing period, expanding the area covered by agricultural fields and improving their productivity on a sustainable basis are components of quite common and widely applied development strategies. There have been many successes in this approach, especially from marginal regions where dependence on monsoon rains have been superseded by a steady supply of irrigation water from perennial sources. Mountain regions have been quite marginal to such planning as projects depend on large-scale structures, with major dams creating storage reservoirs to feed canal networks the size of medium rivers in the plains and piedmont areas. The water supply for such projects was tapped from the huge glaciated regions up in the mountains, which have been labelled the water towers of Asia, conducted through major rivers to the densely populated lowland regions. In Pakistan irrigation projects initiated by public institutions and development agencies were concentrated in the compact irrigation oases in Punjab and Sindh, which evolved into their present status from systems begun in colonial times.

The last two decades, however, have signalled a basic change in thinking in irrigation design away from the larger projects, towards the development of more small-scale projects. Since then, mountain regions, which provide the meltwater utilized for irrigation in cultivated oases, have become focal points in water management projects of their own.

Development practitioners have been surprised by the highly sophisticated state of local water management systems in mountain societies of the Hindukush-Karakoram-Himalaya belt.[2] Nevertheless, enquiries about their institutional framework and social organization and their impact on existing user communities (Coward 1991) have been neglected and underestimated. This paper presents some of the basic principles of water management and explores some of the local variations and diversity of these principles in a case study from Hunza.

Like the pre-colonial irrigation systems of the Indus Basin (cf. Scholz 1985) the mountain irrigation systems are dominated by gravity flow techniques to transport irrigation water from a source (glacier, snowfield, river, fountain) to the cultivated lands through "gravity-fed" channels. These age-old systems are remnants of indigenous cultural knowledge and traditional techniques. As developers are now searching for models and appropriate technologies that are both sustainable and equitable to apply toward improving these smaller systems, there is a growing need for understanding the institutions of these irrigation systems and how they work.

Hunza presents us with a model for a water users' community in a region where there is water scarcity and which has developed a sophisticated system of water management (Fig. 7.1). The following analysis focuses on this valley society in the Karakoram. It is felt that a comprehensive knowledge of the functioning of the irrigation network of this area will provide us with the key toward understanding its mixed mountain agriculture and social structure.

A side effect of the increasing integration of the high mountain regions into a system of exchange relations with the lowlands and piedmont has been the increased provision of agricultural extension services to the mountain oases and that public (national) and private (international) development agencies have begun to become increasingly involved in local irrigation projects. Three aspects will be emphasized on in the presentation of a multi-dimensional perspective:

1. regional differentiation of ecological frame conditions and their relation toward utilization patterns of natural water resources,
2. effects of historical and societal processes in the legal and organizational structure of water user communities,
3. recent developments in the irrigation economy linked to external interventions and changing economic relations.

From a macro-economic perspective the marginal lands in arid high mountain oases pose a model for the highly sophisticated utilization of a minimum of available natural resources. Water poses a key factor in the whole set-up.

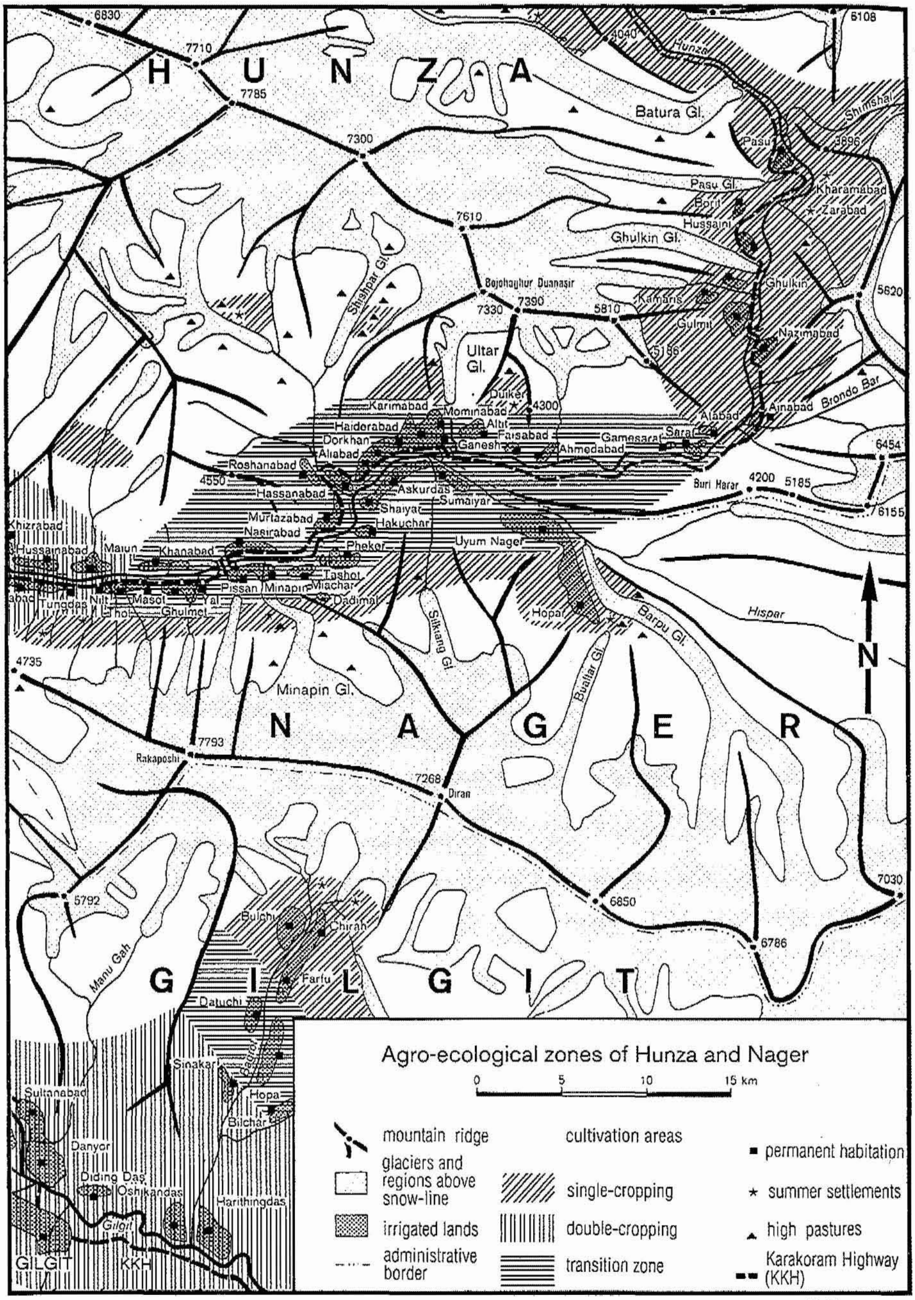

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Figure 7.1: Settlements in the Hunza Valley of the Karakoram: Agro-ecological zones.

ECOLOGICAL AND TECHNOLOGICAL CONDITIONS OF IRRIGATION IN THE KARAKORAM

The Karakoram mountains (71°–79° E, 35°–36° N) petrographically and orographically form one component of the young folded mountain belt of Central Asia (Hewitt 1989; Schneider 1956: 8; Searle 1991). The toponym *Karakoram* derives from the Turkic expression for black gravel or black rock. During the colonial discussion of nomenclature (Mason 1930, 1938) the local term *Muztagh* has been suggested with the meaning of snowy mountains. These two ascriptions present the ecological range of the Karakoram mountains which on the one hand offer gravel and deserts on slopes and in the valley bottoms and on the other hand are characterized in the upper zones by the most extensive ice cover outside the polar regions.

With an average of 28 per cent areawise glaciation and regional up to 48 per cent (Siachen glacier region) these snowy mountains distinguish themselves in ice coverage significantly from the neighbouring Himalayas (8–12 per cent). The whole range of 500 kilometres length is only transected by river gorges at two points: the Shyok river in the East and the Hunza river in the West cut through the main ridge and the Pleistocene deposits thus creating the canyon-like valleys with bordering flat river terraces and outwash fans/scree slopes. The deeply incised main rivers are difficult to tap for irrigation purposes as the elevation between water level and settlement terraces sometimes spans a vertical distance of over 100 m. Traditionally other solutions for the provision of irrigation water were found, such as the predominant utilization of water from tributary rivers. The Hunza valley has some of the steepest slopes on earth that leaves only limited space for cultivation. Between the Hunza river at Altit (2100 m) and the Ultar I peak (7390 m) the average inclination of the slope ranges around 60 per cent.

The valleys represent a typical subtropical steppic high mountain area with altitudinal zonation of vegetation cover. The classification of vegetational belts begins at the valley bottom with desert conditions. Next comes artemisia steppe where most permanent settlements are located. If one follows the slope gradient upwards, humid-temperated stretches where coniferous woods occur locally at northern exposures. Above this is found the zone of high pastures; an important economic resource is composed of valuable meadows reaching upwards to the zone of perennial snow and ice (Paffen, Pillewizer and Schneider 1956).

Climatically the Karakoram mountains form a barrier between the monsoon-dominated lowlands of the Indian subcontinent and the arid belt of Central Asia with its huge desert basins of the Tarim and Fergana. The Karakoram valleys are thus affected by a monsoonal climatic regime as well as by westerly depressions forming a transition zone (Fig. 7.2). In the

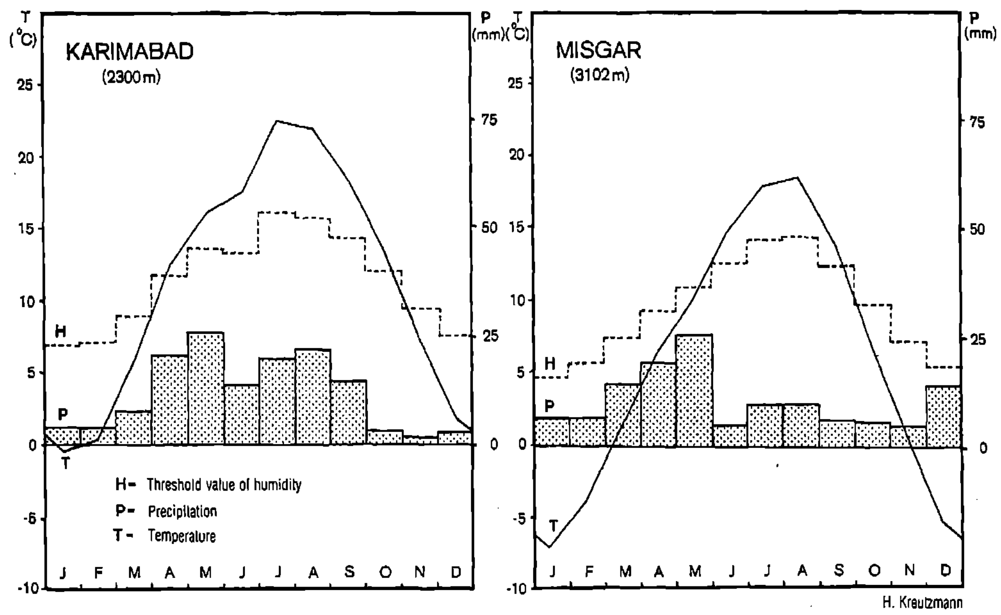
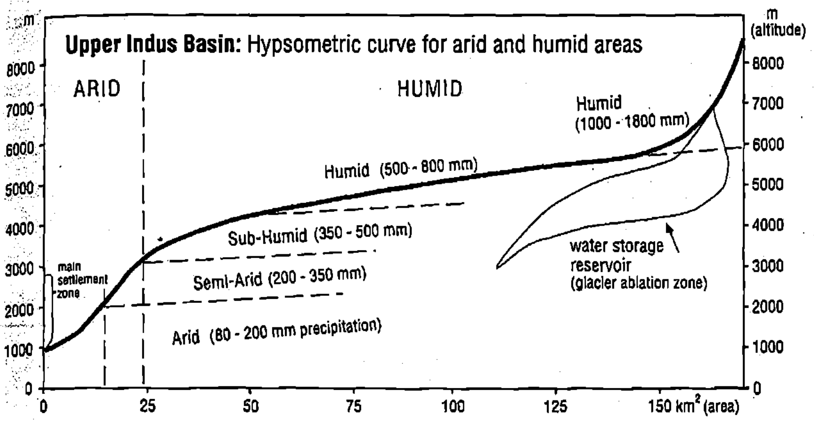


Figure 7.2: Climatic diagrams of Karimabad and Misgar stations.

vertical dimension, extreme differences of precipitation conditions have been recorded between arid, desert-like valley bottoms and the humid nival zone (Hewitt 1989) thus separating potential settlement regions from those where sufficient humidity is available (Fig. 7.3). Climatic data are available for longer periods only from weather stations in the valleys thus showing the limitations for agriculture in the permanent settlements.

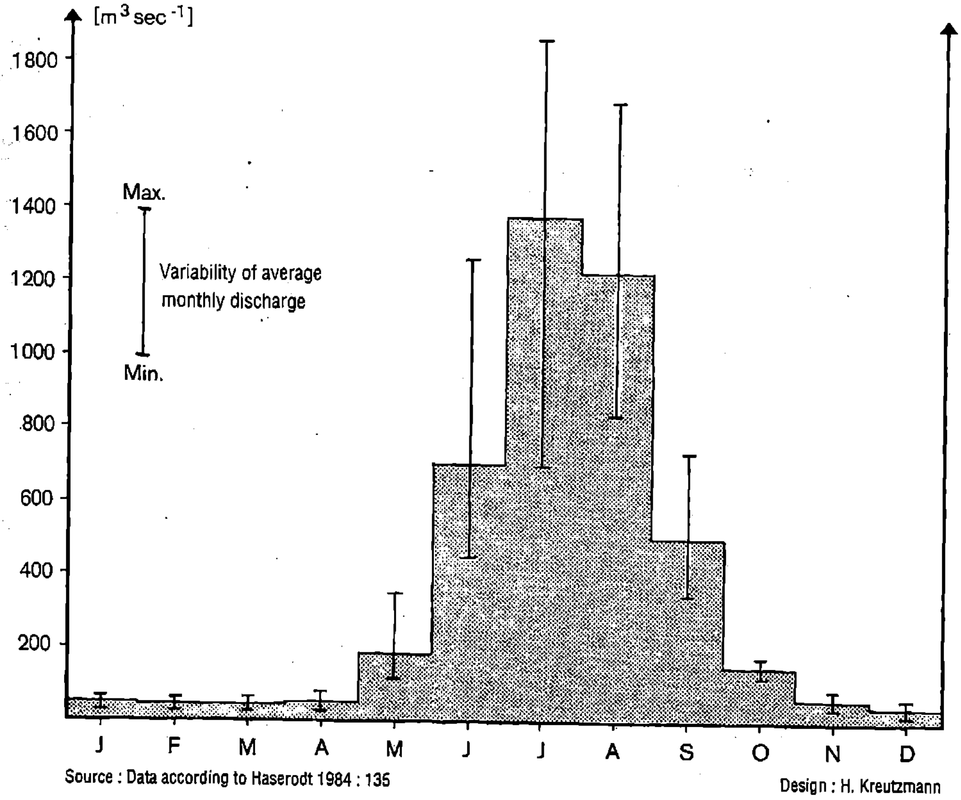
The total annual precipitation in these valleys is only about 130 mm on average and is well below minimal requirements for rain-fed (*barani*) cultivation. On the other hand, measurements of ablation and calculations suggest maximum precipitation at 5000 metres altitude of approximately 2000 mm. This significant gradient explains the desert conditions in the villages and the enormous glaciation in the upper elevations.[3]

Mean average temperatures seasonally vary with maxima in July/August and minima in January with an amplitude of 25° C (cf. Fig. 7.2). In a glaciated region like the Karakoram these variations in temperature determine and actuate the volume of available meltwater for irrigation in the valley bottoms. The seasonal differences are reflected in the discharge patterns of the rivers (Fig. 7.4). The period of seasonal meltwater release relates to the climatic conditions and determines in connection with the altitudinal location of settlements the length of the cultivation period for crops in these irrigation oases. The average duration of annual growing



Source: Adapted from HEWITT 1989 : 12

Figure 7.3: Upper Indus River Basin: Hypsometric curve for arid and humid areas.



Source : Data according to Haserodt 1984 : 135

Design : H. Kreutzmann

Figure 7.4: Discharge pattern of Hunza River.

cycles ranges from 307 days for Gilgit (1450 m asl), 260 days for Karimabad (2300 m) to 195 days only for Misgar (3102 m).

Relief, availability of meltwater and vegetation period in different locations (altitude, aspect) form the parameters for the possibility of establishing sustainable irrigation oases in the Karakoram. The storage capacity of the mighty ice towers is tapped and meltwater are deviated towards irrigated fields in locations which compose ecological and agro-technological niches with favourable conditions for crop farming. Thus the irrigated oases of the Karakoram are located on river terraces and outwash fans in the arid low-lying valley bottoms. They allow a maximum utilization of the limited vegetation period where the provision of sufficient meltwater from side-valleys is safeguarded through a highly sophisticated network of irrigation channels. Overall these cultivated areas cover less than one per cent of the Karakoram mountains.

IRRIGATION AND LAND USE: OASIS AGRICULTURE AND ORGANIZATIONAL STRUCTURES

The rural societies of the Karakoram differentiate themselves in many ways despite a principally similar ecological environment and a relatively homogeneous materialized culture. One of the main characteristics of individual valleys poses the traditional social organization. Staley (1969) has distinguished two basic types:

1. Semi-autonomous and independent *principalities* represent the dominant feature of hereditary rule in the northern Karakoram valleys. Local *mir*, *rājā* or *tham* dominated peasant farmers of different social standing in places like Gupis, Yasin, Ishkoman, Punial, Gilgit, Hunza, Nager, Astor, Skardu and Khaplu. These rulers over a peasant community executed certain control, levied taxes and requested forced labour services from the rural households.
2. Following the Yusufzai Pashtun conquest of Swat and Indus Kohistan since the fourteenth century so-called acephalous societies or *republics* have emerged in the mountainous interface of the southern valleys like Chilas, Tangir, Darel, Gor, Kandia etc. They have established an egalitarian community to which all landowners belong. They are entitled to participate in the decision-making process of all village activities like distribution of land, construction and maintenance of irrigation channels etc. No hereditary ruler is present; every member possesses equal rights. The forum for counselling is the *jirga*, a local assembly basing its decisions on overall consent. Besides the landed members of society

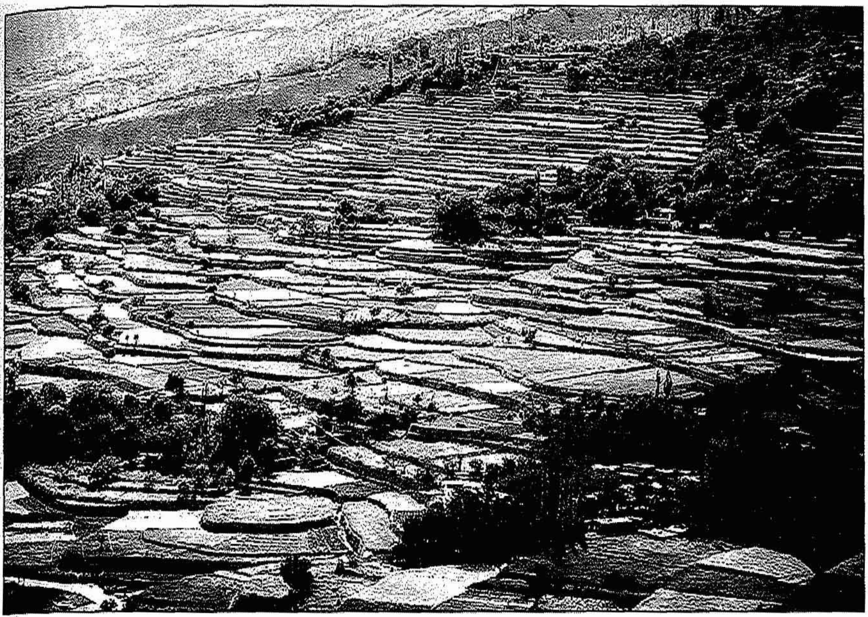


Photo 7.1: The irrigated oasis of Central Hunza, clustered hamlets are scattered in the village lands. In the foreground the hamlet of Barashal located between Dalá and Barber channel. In the background the deeply incised Haiderabad Har, this valley separates the villages of Karimabad and Haiderabad (Hermann Kreutzmann).

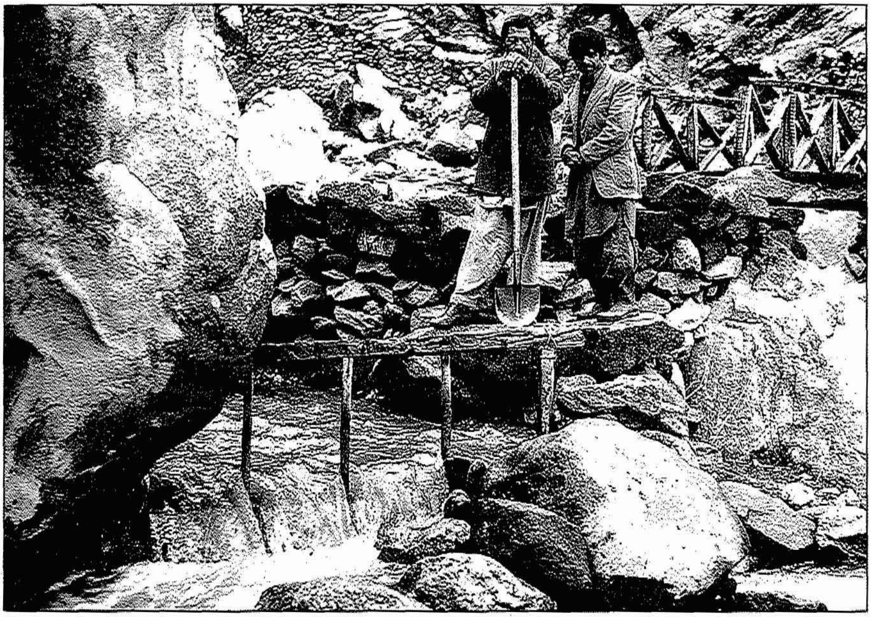


Photo 7.2: Supervisors control the diversion of waters between the main channels of Central Hunza: Dalá, Hamáci, and Altit góčil. Wooden frames support the measurement of shares, here the Altit góčil is taken out (right side) (Hermann Kreutzmann).

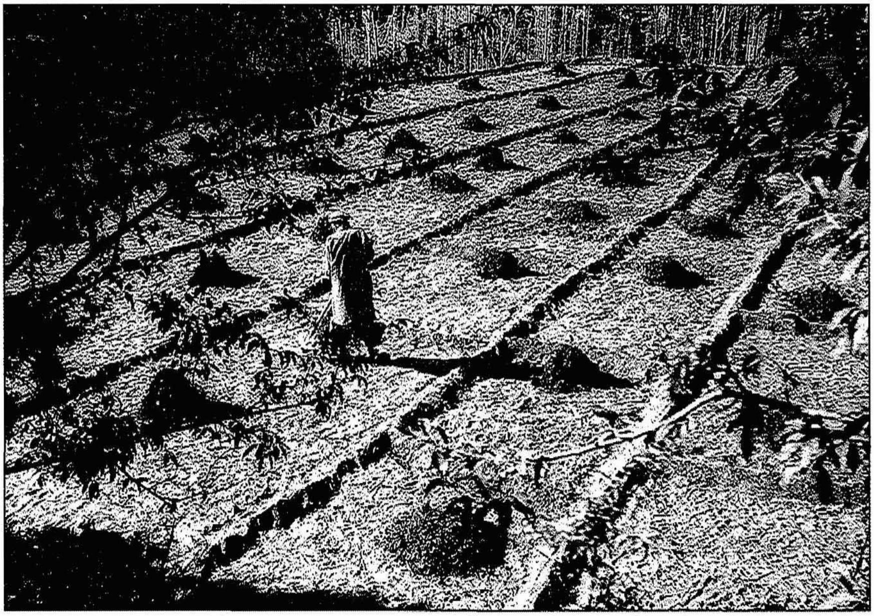


Photo 7.3: The barren plots reveal the patterns of field management in order to supply similar amounts of water to each parcel. Depending on slope and soil characteristics these patterns vary. The round heaps to be seen are mounds of animal manure which is distributed along with the first watering in spring (Hermann Kreutzmann).

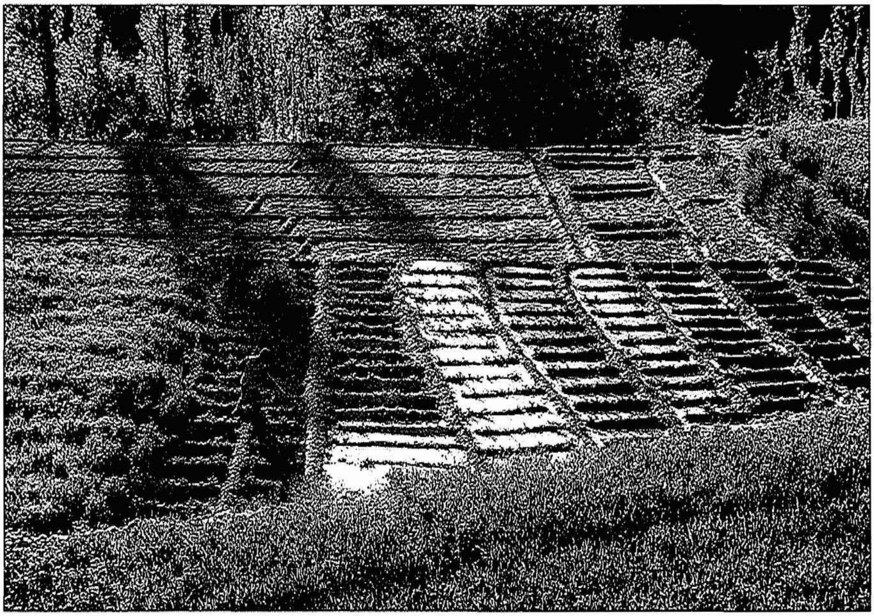


Photo 7.4: In contrast to the flooding of parcels for grain crops potatoes are cultivated and raised by furrow irrigation. The tubers are planted on the ridges and are watered by letting water flow through the furrows. As crops are rotated those ridges are not fixed and involve considerable management (Hermann Kreutzmann).

there exists a subordinated landless class which works on the fields and as shepherds. They are excluded from all decision-making processes.

Staley (1966) observed distinguishing features between these two societal settings. The cultural landscape of the republics was devoid of any orchards, a trait that has been related to the land rotation system of *wesh*.[4] Agricultural tasks are predominantly executed by indebted wage-labourers from outside, who are tolerated as employees. Intensity of crop farming has been low and cultivable land abounds. In comparison with the principalities, the agricultural resources of the republics are abundant and under utilized. There landowners work their small holdings (on average less than one hectare per household) themselves and are engaged in intensive exploitation of available resources. The upper limits of certain crops are significantly higher in the principalities than in the republics. Natural forests have been depleted to a high degree. Scarce water resources are optimized in a highly sophisticated system of water management by ascribing qualified priorities to different crops, orchards and meadows.

In this respect an extraordinary position is held by Hunza which has gained a reputation for the development of marginal resources. Hunza professionals managed to cultivate difficult tracts, their expertise in designing and construction of irrigation networks won them assignments in other Karakoram valleys. In its complexity, the Hunza water management system incorporates a number of rules and regulations that are applied in different configurations in other Karakoram valleys as well. Where water scarcity is the dominating feature like in the irrigation system of Central Hunza the complexity of water management increases.

WATER MANAGEMENT IN CENTRAL HUNZA

The vast majority of all irrigation systems in Hindukush, Karakoram and Himalaya use gravity-fed networks to conduct running meltwater through channels which are directed less steeply than the slope gradient and in some cases nearly parallel to contour lines. The same applies for Hunza where the village lands receive their "glacier milk" from channels that supply enormous amounts of suspended matter at the same time.

This characteristic surface irrigation system consists of main channels (*dalá*, *khul* or *góčil*) which start at the head-works with a diversion of water into filter basins. These are necessary to settle huge amounts of suspended silt and sand from the meltwater before sending it down the network. Despite these efforts, much sediment still has to be cleared annually from the main channels before the irrigation season starts. The irrigation water is distributed to the fields through a system of secondary channels (*ṣuṅ*) which follow the slope gradient. Farmers operate two or more main channels at different elevations (Fig. 7.5). Besides supporting the distribution of water to the field channels, these *ṣuṅ* are necessary for the diversion of water from one network to another in case of breaching and to allow for drainage. All main channels below the highest level one are multi-functional.

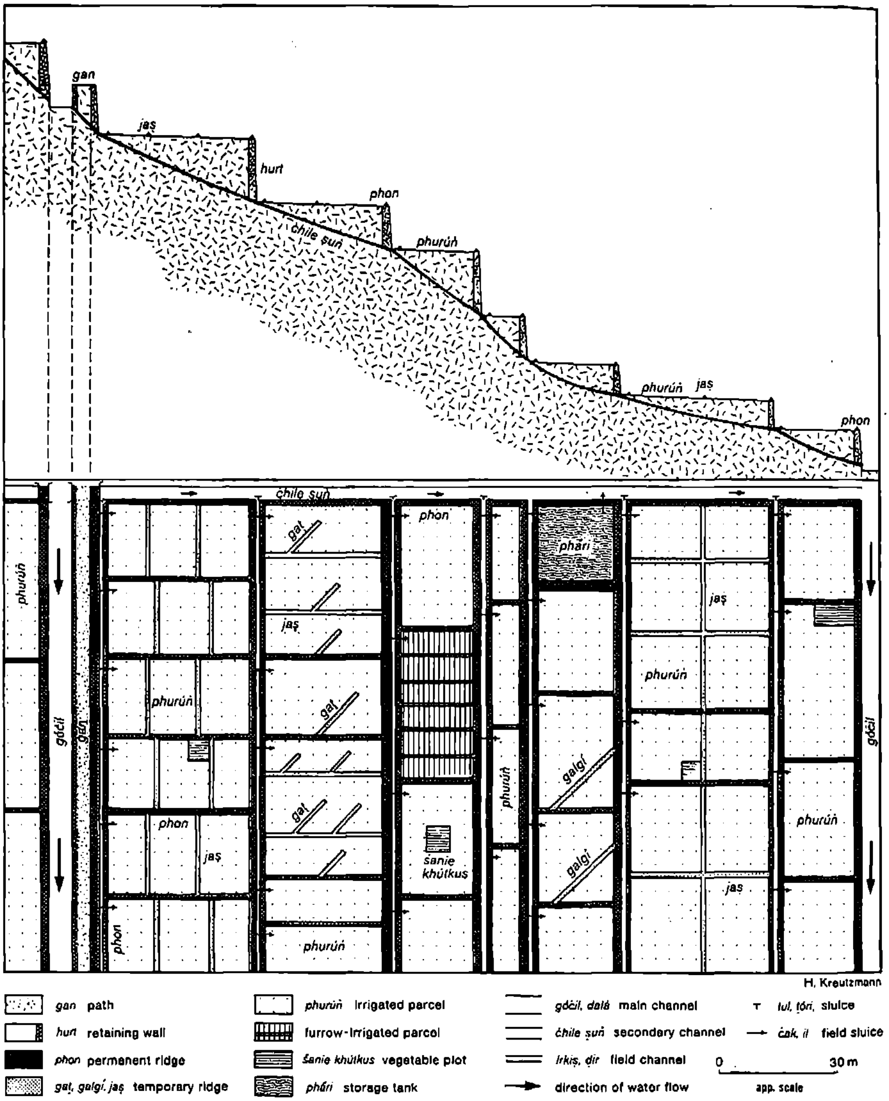


Figure 7.5: Schematic representation of channel system in Central Hunza: Cross section and overhead view plan of irrigated fields.

Individual fields receive their allocated share of water through field channels (*ḍir*, *irkiṣ*) which reach all parcels through the opening and closing of individual field sluices (*ċak*, *il*). Two different types of cultivation beds (*phurúṅ*) are used in Hunza: flat parcels for the raising of grain crops and leguminous plants in which some small patches for vegetables (*śanie khúṭkus*) are inserted, and furrow beds for root crops predominantly potatoes. The flat parcels account for 97 per cent of the cropland (*hárkiṣ*; Fig. 7.6)

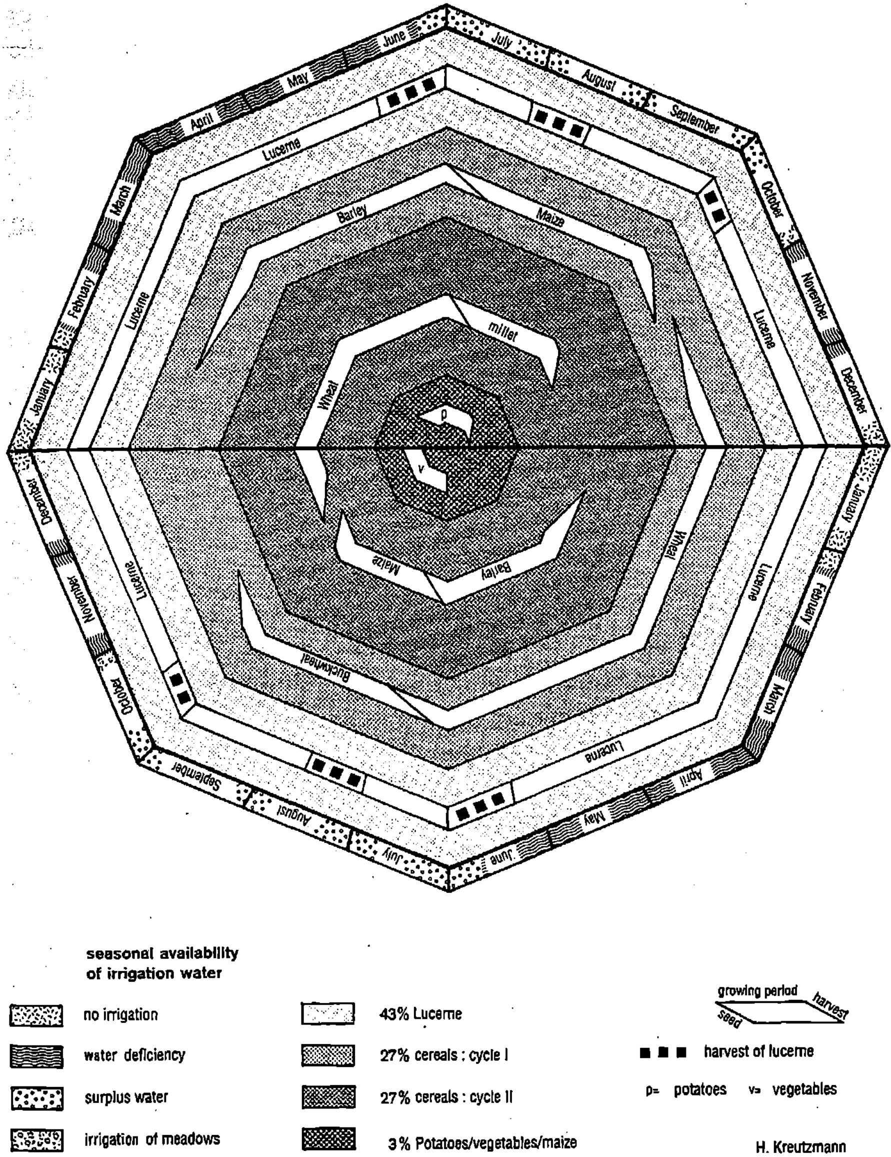


Figure 7.6: Crop rotation and cultivation pattern of Karimabad.

and receive irrigation water through flooding. The furrow beds are allocated water by opening and connecting these furrows during a single cycle. The cultivation beds meant for the raising of the staple food crops (*hárkiṣ*) of the village lands (*ićit*) commands first priority of water rights and is given preference against orchards (*basikiṣ*) and irrigated meadows (*ṭoq*). The latter are only irrigated during periods of surplus water. These irrigation techniques and priority measures are structuring the village lands.

In regions with a limited supply and intensive cultivation further measures are taken to optimize the use of the available water by levelling the terraces and applying a complex distribution key. Where water is less a factor in the farming system, its management requires less effort and less emphasis is placed on setting up rules and controlling consensually fixed regulations.

Evolution of Channel Network and Adaptation of Irrigation Rules in Central Hunza

The historical dimension in an expanding irrigation system in Central Hunza can be linked to initiatives of different rulers. The core of this system was formed by an old structure of the three oldest settlements, which were supplied with water from individual channels leading to their respective village lands. The Hamáĉi channel forms the lifeline of Ganesh, and Altit góĉil brings meltwater to the village of the same name. Both channels tap the Ultar glacier as their main resource. The Balti-íl links the fortified village of Baltit (renamed Karimabad since 1983) with the waters of the Búlulo snowfields and springs. This poor resource basin is drained by the Haiderabad Har which provides the Balti-íl its offtake. The age of these three oldest channels of Central Hunza has not been established, but they could be well over 600 years old.[5]

No important extensions to the system were contemplated until Tham Silum Khan III (app. 1790–1825) founded several new villages (*thuaáṅ khanánċ*). His reign can be characterized as a period of population growth, immigration of settlers, territorial gains and strengthening of centralized authority in Hunza. In order to establish settlement nuclei in the newly cultivated irrigation oases, he directed the construction of the *thuaáṅ khanánċ* as fortified villages. The name of Silum Khan III is associated with the main channel of Central Hunza. The *dalá* (big channel) or Khul Samarkand, as it is locally called, still irrigates the lower portion of the central irrigation oasis between Karimabad and Aliabad (Tab. 7.1).

Tab. 7.1
Construction periods of irrigation networks in Hunza

period of construction	topographical specification or locality of irrigation channel	organizational head of project/ institution	irrigation expert/local engineer
?	Balti-íl (Baltit)	—	—
?	Hamáći (Ganesh)	—	—
?	Altit góćil (Altit)	—	—
1790–1824	Dalá (*thuaáṅ khananċ*), Ahmedabad, Misgar, Ghujal	Silum Khan III	Puno
1824–1865	Barber, Murku (Diráćil)	Shah Ghazanfar	Asadullah Beg
1865–1886	Murtazabad, Khudabad	Shah Ghazanfar	Asadullah Beg
1892–1916	Shishket, Sost, Atabad, Khizrabad	M. Nazim Khan	Humayun Beg
1892–1916	Reminj	M. Nazim Khan	Mahmud (Haiderabad)
1895	Hasanabad (trial with support from colonial administration)	M. Nazim Khan	Humayun Beg
1904	Khanabad (Motos or Murtus)	M. Nazim Khan	Humayun Beg
1904	Hasanabad (trial on left bank)	M. Nazim Khan	Dorfinitiative
1904	Gircha (new project)	M. Nazim Khan	Humayun Beg
1904	Matum Das (first phase)[a]	M. Nazim Khan	Humayun Beg
1916–1935	Maiun-Hussainabad	M. Nazim Khan	Shukrullah Beg
1921–1935	Reshit, Kirmin, Ispenj, Ghalapan, Imamabad	M. Nazim Khan	Shukrullah Beg
1938–1939	Oshikandas	M. Nazim Khan	Zarparast
1938–1942	Imamyári	M. Nazim Khan, Ghazan Khan	Zarparast
1940	Danyor	Ghazan Khan	Zarparast
1948	Karágadimuċ	Jamal Khan	Inayatullah Beg
1950	Sarteez (Gircha)	Jamal Khan	?
1960	Dilbar[b]	Jamal Khan	Sajidullah Beg
1960	Jamalabad	Jamal Khan	Ghulam Jaffar, Titam
1973	Rahimyári	Jamal Khan	village group
1980	Bulzum góċil (Haiderabad)	—	village group
1982–1992	48 irrigation projects in different locations	AKRSP-Village Organizations	Hussain Wali Khan

a) Wazir Humayun Beg led the construction work of Hunza farmers at Matum Das, a location which had been given up by the previous occupants after a natural disaster had destroyed the existing channels and subsequent attempts to reconstruct the irrigation system had failed. His attempt led to success by December 1904; his engineering expertise was especially highlighted in the report of the Political Agent, Gilgit (IOL/P&S/7/172/ 2263A; IOL/P&S/7/173/283). The cost of construction amounted to Rs 1600 (IOL/P&S/7/173/351). The distribution of land started in January 1905 (IOL/ P&S/7/174/428). During this first phase land was allocated for twenty households in Matum Das (IOL/P&S/7/178/1038).

b) The Dilbar project has been a failure due to environmental hazards which led to the abandonment of the project. It has only been taken up again recently, completion is expected in 1999.

Source: AKRSP 1989: 52; AKRSP 1992: 24–28; IOL/P&S/7/165/1094; IOL/P&S/7/171/2013A, 2142A; IOL/P&S/7/172/2263A; IOL/P&S/7/173/283, 351; IOL/P&S/7/174/428; IOL/P&S/7/178/1038; IOL/P&S/10/826: 16, 18, 60, 66, 240; IOL/P&S/10/973: 161, 226, 243; IOL/P&S/12/3285; IOR/ 2/1075/217: 50–54; IOR/2/1083/ 286: 11; Lorimer 1935–8, II: 353; Müller-Stellrecht 1978: 114; Nazim Khan 1936: 120; PRO/ FO65/1507: 29; Singh 1917: 27 and own data collected by observations and interviews 1984–95.

All settlers of Baltit participated in the construction of the new channels and through this the people of the *thuaáṅ khanánċ*, originating mainly from Baltit (the filial settlements of Haiderabad and Aliabad are composed of the same kinship groups as Baltit), were connected to the *dalá*. This new channel afforded a revised distribution key for the Ultar meltwater, dividing half of the available water into the *dalá* network (two shares), while one share each was allocated for Altit góċil and Hamáċi. This distributive formula is still being followed and gives priority to these oldest channels in periods of water scarcity (autumn to spring).

During summer, when surplus irrigation water above the carrying capacity of the old channels is available, newer channels are eligible for water shares. This newer group is composed of channels constructed under the guidance of Silum Khan's successors. His son and grandson found in *wazir* Asadullah Beg (1847–85) an able local engineer for further irrigation projects. Members of his own clan respect his name especially as he enabled the Diramitiṅ to tap the Diráċil spring and command its waters. In addition to this achievement, he supervised the construction of the second major channel of Central Hunza bringing water to the upper fields. The Barber following the course of the *dalá* on a higher contour line supplied the water for newly meliorised fields above the traditional village lands.

On the one hand new channels provided arable land for a growing population, on the other channel projects executed under forced labour conditions (*rajaáki*) increased the land resources and income of the hereditary ruler and the *wazīr* households. These main channels of Central Hunza were established around 1850 and compose the skeleton of the present-day network. A number of smaller and secondary channels complete this system. Water to be distributed in these later built channels can only be supplied during periods of surplus and they therefore serve only a marginal role compared to the main channels in Central Hunza.

During the twentieth century the enterprising ruler Mir M. Nazim Khan (1892–1938) initiated another phase of channel construction (Tab. 7.1). His irrigation policy was characterized by the establishment of new village oases outside Central Hunza in the single-cropping zone of Ghujal and down the Hunza River in the double-cropping zone of Shinaki (cf. Fig. 7.1) thus tapping unexploited or under utilized sources of meltwater. These young villages command, on average, a good supply of water and require fewer rules and regulations than the core oases. In this area, even with its simple regulations, the expansion of the irrigation network and the construction of new channels have contributed to the overall complex codex of water rights for Hunza. In these new areas different rights of water allocation have been laid down for certain channels both for periods of water shortage and surplus. On the other hand the irrigated lands are classified in three groups:

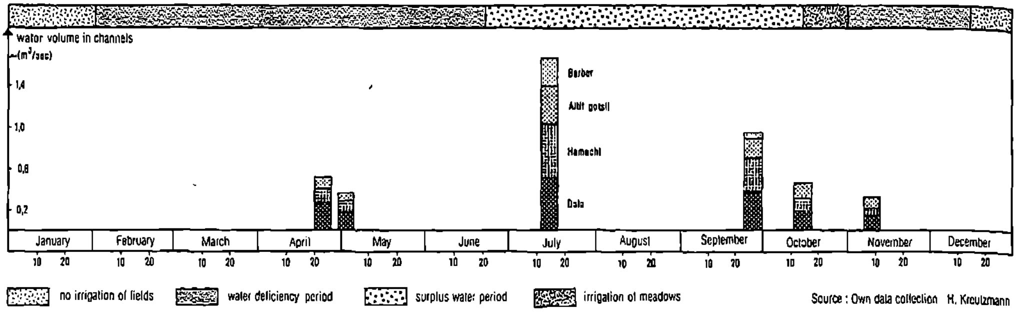
- First priority of irrigation belongs to cropland (*hárkiṣ*) which requires regular watering during the different growth stages and on which the staple cereals are produced,
- Second priority goes to the orchards (*basíkiṣ*) providing an additional nutritional base to the villagers from fruit trees which require less intensive and less frequent water supply,
- Third priority goes to irrigated meadows (*ṭoq*) on steep slopes within the village lands which are entitled to excessive water supply only during non-growth stages in the other parcels.

This allocation pattern for village lands reflects an irrigation order with preferential treatment of differentiated production zones more than the agro-ecological setting. In channels with "old" water rights, like Balti-ĩl and Barber, one would predominantly find orchards as only surplus water is available for irrigation, not sufficient for cereal production in quantity and variability. During the short period after harvest and before sowing the winter crops no irrigation water is needed for agricultural lands and orchards. Thus the irrigated meadows (*ṭoq*) are qualified for the full load of available irrigation water (Fig. 7.7).

IRRIGATION CALENDAR FOR CENTRAL HUNZA

Seasonality plays a major role in the flexible approach to organizing water management in Hunza. The quantity of meltwater released from Ultar glacier depends on temperature variations which is reflected in the discharge patterns of the tributaries of the Hunza river (cf. Fig. 7.4). The irrigation calendar for Central Hunza takes into account that periods of surplus alter with periods of grave deficiency. The basic water supply is precisely distributed during all seasons according to a legal set which is binding to all participants. This codex is common knowledge and not written down or fixed like in other mountain regions. The contemporary set of rules and regulations is the result of historically acquired water rights of user groups and modifications directed by the hereditary rulers.

The participation of clans and village communities in the construction of new irrigation channels secured their rights to water and lands. Individual channels belong to certain groups of this denomination exclusively. A second



Source : Own data collection H. Kreutzmann

Figure 7.7: Measurements of water flow in irrigation channels of Central Hunza 1985.

criterion for water distribution is the traditional right of access to irrigation water belonging to certain clans or kinship groups. In cases of kinship and spatial congruency, i.e., when the parcelling of village lands follows a group structure, water distribution is highly efficient as certain areas are irrigated at the same time. Seepage and water losses in a dendritic irrigation network are thus minimized.

Baltit or Karimabad poses an ideally structured example for this kind of setup. Sectors of the village lands are distinguished as belonging to certain kinship groups. The quarters of the four clans of the Dirámitiṅ, Buróoṅ, Barátaliṅ and Qhúrukuċ define the agricultural oasis only modified by the possessions of the hereditary ruler. The *miri* lands were traditionally located in every favourable cultivation area, like in Bul Mal, Karimabad (Suryas Das), and Bishker. In recent years the majority of the *miri* lands have been sold to individual villagers of Karimabad thus we find there a mixed kinship-related ownership.

A synoptic table of water rights, irrigation cycles and rules of distribution for the main channels of Central Hunza presents the historic evolution and complexity of water management (Tab. 7.2). First priority of access rests with the oldest channels and rights acquired through kinship participation in the construction of channels. Measurements of water flow in different seasons (Fig. 7.7) proved the applicability of distribution keys. The share structure—Dalá: Altit góčil: Hamáči = 2:1:1—is controlled at certain gates where the water flow is diverted into the different systems. In periods of deficiency extra guards control the exact adherence to these distribution keys while during surplus phases control is relaxed.

A second method of rationing is the hourly or daily right of water utilization. For example, the Búlulo water is split in a rhythm which allows the inhabitants of Karimabad (Baltit) to use it for ten days, while the Haiderabad people's share is only six days. The water in the Barber channel belongs to the community of Karimabad during the day, while at nighttime the users at the lower end of the Barber (Haiderabad-Dorkhan-Aliabad) safeguard all water for the irrigation of their respective fields. Priority rights of the *tham* included a sufficient share of water and the irrigation of his fields only in favourable daylight conditions. Even after the abolition of hereditary rule in 1974 the traditional *miri* water rights remained valid through the connection of water and land rights.

Tab. 7.2 Irrigation Calendar of Central Hunza

water source	channel system/ priority of supply	water right	duration of cycle (days)	water distribution (one cycle for each system displayed) (* = daytime; + = nighttime)	decision about turns/sequence	No. of water guards
Ultar (glacier)	Altit gócil (first priority)	one share for Altit (all year)	4½	TUUHHKKSS T = tham *+*+*+*+* U = Usénuc H = Hakálokuc K = Khanúkuc S = Susurdotin	annual draw of lots	2
Ultar	Hamáci (first priority)	one share for Ganesh (all year)	6	GGGGABCDFFFF G = Gamu Ganesh *+*+*+*+*+*+ Ganesh Giram A = Buldas B = Shuknoshal C = Shaboikushal D = Silganish F = Gerelt	fixed sequence overall; day & night turns in Giram	2
Ultar	Dalá (pir gócil, mákucim gócil) (first priority)	two shares for thuaán khanánc	Feb-May: 10	HHAAAAAAAAAAAAAAAAAA *+*+*+*+*+*+*+*+*+*+ H = Haiderabad A = Aliabad (with Dorkhan)	annual change from E - W to W - E	3
			Jun-Sep: no cycle	tul system: 2 Haiderabad (outlet hole) 1 Mominabad 1 Baltit 1 Bishker		
			Oct-Nov 10	same like Feb-May (cf. above):		
			Dec-Feb	drinking water only for thuaán khanánc		
Ultar	Karagadimuc (first priority)	all year round	no cycle	solely for *tham*	–	1
Ultar	Baber (surplus only: first priority)	surplus water from Jun-Sep: day-time: Balti night-time: thuaán khanánc	7	BHBHBHBDBABABA B = Baltit *+*+*+*+*+*+*+ H = Haiderabad D = Dorkhan A = Aliabad	–	2
Ultar	Imamyari; Rahimyari (surplus only: second priority)	surplus water for Altit (after Barber is filled)	–	according to Altit village key (cf. above)	–	1
Dirácil (spring)	yarum Murku; yatum Murku	Dirámitin of Baltit	–	additional irrigation of Dirámitin ícit	–	1
Búlulo (snow & spring-water)	Balti íl (yatum dalá) or Haligan (Barber) (first priority)	3/8 Haiderabad (= 6 days); 5/8 Baltit (= 10 days)	Feb-Jun: 16	DDAAUUQQ1122AAAAAUUUUUQQQQQDDDDD *+*+*+*+*+*+*+*+*+*+*+*+*+*+*+*+ Haiderabad | Baltit D = Dirámitin 1 = Baskaotin1 A = Barátalin U = Buróon 2 = Baskaotin2 Q = Qhúrukuc	four-year cycle in Baltit 1985: AUQD (E-W, top-bottom);	1
			Jun-Dec: 16	DDAAUUQQ1122AAAAUUUUUUQQQQDDDDDD *+*+*+*+*+*+*+*+*+*+*+*+*+*+*+*+ Haiderabad | Baltit	1986: UQDA (W-E, bottom-top)	
Búlulo	Buróon gócil; Barátalin gócil; Qhúrukuc gócil (surplus only)	10 days Baltit (after Barber is filled)	16	distribution in accordance with Balti íl		1 1 1
	Bulagas; Turagas; Bulzum gócil (surplus only)	6 days for Haiderabad (after Barber is filled)		distribution in accordance with Haligan		1 1 1
Asha Har (snow & spring-water)	Asha gócil	6 days for Haiderabad 1 day Dorkhan	7	HHHHHHHHHHHHDD H = Haiderabad *+*+*+*+*+*+*+ D = Dorkhan	fixed sequence: Fridays for Dorkhan	1

Source: Own survey and data collection

The user communities distribute the allocated water among themselves according to allocation keys which are laid down by their members. A complex system is applied in Haiderabad. Six days of Búlulo water have to be divided among four kinship groups (the same like in Baltit). The Haiderabad people have formed six user groups of equal size. Four groups consisting of Dirámitiṅ, Buróoṅ, Barátaliṅ and Qhúrukuċ, respectively, and two groups of Baskáotiṅ (from *bask*, literally meaning surplus, in addition). The members of the Baskáotiṅ are the extra households of the four clans that are numerically in excess of the group size.

On the other hand, in Karimabad the ten-day-cycle is distributed among the four *ròom* in a manner that schedules irrigation for two days and three nights or three days and two nights are allocated to the relevant kinship groups. Every year a different clan begins the irrigation cycle thus avoiding any preferential arrangement for individual kinship groups. Within these user communities the irrigation sequence varies annually from top to bottom and from East to West (cf. Tab. 7.2). These examples illustrate the wide range of possible communal agreements that have been established in order to safeguard equity for all users.

These cycles of six or ten days respectively present no real indicator for the actual time required to irrigate all the fields of a user group. In periods of water deficiency, e.g. during the sowing of winter wheat (*Triticum aestivum*) in November/December or of summer barley (*Hordeum vulgare*) in February/March, the total time necessary to irrigate all fields once could amount to forty-eight days. In order to maximize the use of available water the whole community has adapted a cultivation pattern in which the first crops of winter wheat and summer barley are represented in equal quantities (cf. Fig. 7.6). Both are sown in deficiency periods. On the contrary the second crops like maize (*Zea mays*), millets (*Panicum miliaceum*; *Setaria italica*), potatoes (*Solanum tuberosum*) and buckwheat (*Fagopyrum esculentum* and *tataricum*) are exempted from such regulations. In summer, surplus conditions of no water shortage prevail and the entire village land of Central Hunza can be irrigated within a sixteen-day cycle.

Valuable water resources have to be distributed according to systematic management and plant requirements. Top priority is given to cereal crops on irrigated terraces (*hárkiṣ*). After the first watering (*burúui*) of all wheat fields, barley is irrigated. Then follow potato furrows, vegetable plots (*śaníe khúṭkus*) and at last lucerne (*Medicago sativa*). This regulated sequence is repeated at the second watering (*yátcil*) and is only relaxed when sufficient water is available in the old channels. With the end of restrictive water use, the first irrigation of orchards (*basíkiṣ*) is permitted. The timing of this date in relation to the summer solstice (21 June) gives the measurement for the classification of a good or bad "water year".

This complex system of rationing is applied in Central Hunza in those settlements that command limited water sources or have grown beyond their resource capacity. Communities with abundant irrigation water do not need such a highly sophisticated distribution key to safeguard a high probability of sufficient crop production. Villages like Altit, for example, allot the annual sequence of irrigation every year through the drawing of lots, while in Ganesh the rotational structure is fixed.

Different kinship groups are in command of day or night cycles. Some water rights incorporate structural inadequacy of the systems, such as in the case of the Barber channel, where parties whose parcels are located nearer to the source are given preference. Karimabad as a whole is allowed Barber water during daylight hours, while Haiderabad, Dorkhan and Aliabad utilize the precious resource at night. The farmers of the Diramitiṅ kinship group in Karimabad profit from the location of their agricultural lands in the same manner as the people of Haiderabad and can divert any needed quantity of water to their fields. The difficult location of Aliabad at the lower end of Barber, Dalá and Pir góčil results in greater water deficiency in this village than in others. Topographical features in combination with settlement history pinpoint the structural injustice. An additional factor contributes to the water supply situation, for along the course of the 10 kilometre-long open channels a substantial quantity of water is lost by evaporation and seepage.

Water channels function as multipurpose lines. Besides irrigation, the system provides all washing and drinking water as well. Unfortunately, such channels furnish poor quality drinking water badly effected by contamination. Thus without control of its own water sources, the second biggest village of Hunza, Aliabad, is the most dependent on other areas for drinking and irrigation water supply. The village community is eager to reduce further losses and irrigates all fields consecutively: one year the irrigation starts in the east, the following year in the west.

Ecological limitations are responsible for these rules and regulations to a lesser degree than socio-political and historical events. They laid the foundations for water rights of certain user groups which have to be defended against competitors. Water surplus and deficiency regions are defined by traditional rights of individual groups. Complex irrigation systems afford community efforts during construction and regular maintenance in which all social groups (household, kinship group, and village) are involved on different levels of participation.

ORGANIZATIONAL ASPECTS OF WATER MANAGEMENT

The *tham* of Hunza has traditionally taken the initiative for the planning and execution of construction work on irrigation channels. He normally involved his *wazir* in this enterprise of state importance in his dual function as prime minister and executive engineer for planning and supervision. The respective kinship groups or village communities served as construction workers. Early major channel projects accomplished general construction with simple technical devices and tools like wooden shovels and ibex horns (cf. the contribution of Hussain Wali Khan and Izhar Ali Hunzai in this volume). Sheer cliffs were mastered with support structures made of wood and stone. The reputation of *wazir* and workers increased through ingenious channel alignments and they secured usufructory rights to the meliorated lands through their participation in *rajaáki.*

Communal work of comparative size is only called for in certain cases nowadays, for example when a new storage tank (*phári*) has to be excavated or when a channel has been breached. In the latter case, all user households have to co-operate until the breached channel has been repaired or until new course has been excavated. Except for these exceptional or episodic events, fewer individuals are required in the management of channel systems through the regular activities of operation and maintenance.

The annual cleaning and repair work starts prior to the first irrigation of crops in spring. Farmers who own land within the channel command area are obligated to remove the deposited sediment of the previous year from the channel-bed. These activities were traditionally controlled by the *wazir,* who supervised the works and possessed the right to sanction those who do not participate according to the rules (cf. Lorimer 1979: 126–133). His influence in allocating the various jobs in water management contributed to his esteem as the chief hydraulic supervisor.

When Hunza lost its autonomy in 1974, the *wazir's* post was abolished along with the post of the *tham*. The traditional functions of the *wazir* are nowadays executed either by the *lambardār* or by village committees. Every year the group of village elders assembles in a *jirga* that distributes the remunerated water management posts among community members for the coming irrigation period. The *jirga* nominates a supervisor and the water workers (*ċhilgálas*) who safeguard the correct distribution schedule and the allocation of water to individual land parcels. They are responsible for checking water theft and have to announce the timing of irrigation to individual households. Minor maintenance work is done by the *ċhilgálas* as well. Non-participating households pay a fixed amount in kind or money that basically pays the salary of the water workers.

The number of *ċhilgálas* and the water rates are negotiated anew each year and depend on the size of the available village work force. Traditionally these salaried duties formed a highly esteemed way of providing an income to those households with insufficient lands to profitably employ their surplus male work force. Given changes in socio-economic conditions with increased labour emigration and more farmers involved in non-agrarian occupations, such traditional jobs in water management have lost their attraction. This has resulted in increased salaries for these irrigation workers in order to secure local personnel and to safeguard the system of water distribution. Though the cash investment in hiring such people remains within the community, the difficulty in obtaining reliable and expert people for these tasks causes a growing problem for some villages.

Nowadays, often even elderly and retired men are appointed as water guards (*yáṭkuin*) to supervise the proportional and equitable distribution of irrigation water at the channel heads. These functionaries are elected for one year and safeguard the fair allocation of water to different communities. The *yáṭkuin* are responsible for all duties at the channel heads including the cleaning of sedimentation tanks in which suspended sand particles are precipitated. During periods of surplus water, the *yáṭkuin* limit the flow capacity of individual channel systems to avoid breaching of channels. The *yáṭkuin* reside in simple huts or caves in the Ultar *nālā* and in the vicinity of important channel bifurcations during the entire irrigation period. After the end of harvest in autumn they are remunerated in kind, collecting 1–2 kilograms of wheat per channel from every household.

In times of water shortage additional supervisors are brought in to support the appointed guards. Settlements like Haiderabad cannot afford water loss during the early stages of plant growth when overall water shortage in central Hunza increases the chances for water theft by individual farmers. Thus during nighttime, villagers control all ten outlets along the way from Karimabad to Haiderabad in order to protect all *ṭul* and *ṭóri* from being opened unlawfully. In spite of these measures, water theft along with inheritance quarrels still account for the majority of disputes in Hunza each year.

Traditionally the *tham* fined those found to be stealing water in kind, taking a good share of the penalty for himself. Nowadays the local Ismaili Arbitration and Reconciliation Boards are involved in the legal proceedings. They operate cost-free and compensate the winning party with the entire fine. Some cases are even presented before the public courts (see the contribution by Anna Schmid elsewhere in this volume).

The analysis of the irrigation system in central Hunza has revealed the spectrum of different water rights and organizational rules based on traditional access to resources and an effective utilization of a limited resource. Fair distribution among entitled community members forms the principle in an approach which rejects the separation of water and land rights. Supervision and control of the irrigation networks that nowadays have become community members' own property is executed by themselves on the basis of consent. Scarcity and complicated distribution keys have increased the bureaucratic burden of water management. In periods of deficiency small but highly valued quantities of water have to be guarded on their way to the fields. This practice requires substantial manpower, as sluices are numerous. At the same time the system always favours the users residing close to the water source. Generally, they are the oldest settlers of the oases.

Future projects for the construction of new channels have to respect the traditional water rights. This precondition involves certain limitations: Excess meltwater can only be utilized during summer surplus periods. In all other seasons there is no additional water supply available to be tapped. New channels cannot reduce the ubiquitous seasonal water deficiency. Thus the scope for the extension of irrigated areas lies mainly in the reduction of seepage and evaporation in existing networks.

RECENT DEVELOPMENTS IN THE IRRIGATED OASES OF HUNZA

As explained above, new channel projects increased Hunza's power and economic base during the reign of hereditary rulers and their *wazir*. The range of such enterprises was not limited to the main settlement oasis of Central Hunza (cf. Tab. 7.1). Territorial claims and gains were manifested through the establishment of new villages in the southern and northern periphery. Such projects could involve groups of 20 to 100 household members, which were supported by their families in the early phase of meliorisation. Resettled farmers from Baltit and Haiderabad and refugees/migrants from Wakhan supported expansive plans of the *tham* in the upper Hunza valley (Ghujal) and founded several villages there (Fig. 7.1). This single-cropping zone abounds with water sources when compared to the other regions.

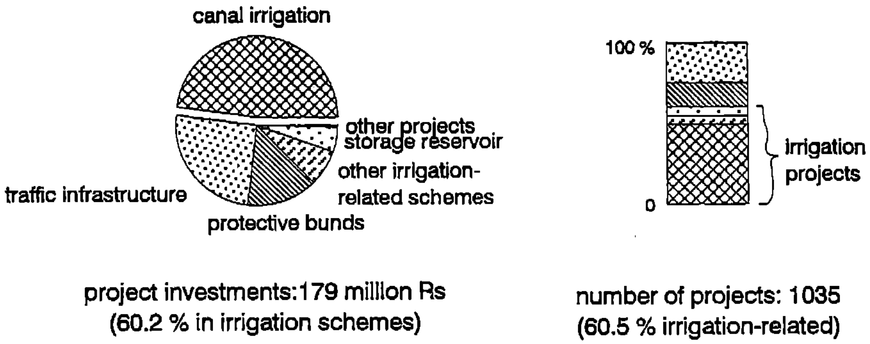
In the lower Hunza valley (Shinaki) a limited quantity of meltwater from the Maiun *nala* was utilized to establish a number of fortified villages in the double-cropping area. The main period of internal colonization is connected with the name of Mir M. Nazim Khan (1892–1938) who established a number of villages for a growing population. His successors initiated only a few additional channel projects (Tab. 7.1). The end of hereditary rule in the Northern Areas by 1974 left a power vacuum which was supposed to be filled by institutions from the Pakistan administration. Their involvement in infrastructure projects dramatically increased after the completion of the Karakoram Highway (Kreutzmann 1991, 1993, 1995a, b). Within the Northern Areas a few attempts to establish new irrigation projects were undertaken while in Hunza itself, village communities executed their own channel building using traditional techniques. Village elders were entrusted to supervise the planning and construction of a number of minor projects.

Different development agencies discovered this structural power vacuum and based their target-oriented approaches on self-reliance strategies. Village Production Groups (VPG) and Village Organisations (VO) took over the role of decision-making once held by more traditional institutions such as the *tham* and *wazir*. These institutions now identified necessary physical infrastructure projects and managed the workload seeking financial and technological support from external development aid. These agencies have supplied cost-free technical advice to the villages through local engineers in their employ. Other major differences from the past have been that:

- The construction cost is now covered from outside sources; man-days are paid for and not supplied through forced labour (*rajaáki*);
- The channels belong to the community working on them; all participants are entitled to an equal share of water in the irrigated lands. No extra plots are reserved for the *tham* and *wazir* or any other high status individuals anymore;
- Water management and maintenance of channels is delegated to professionals (*chowkidār*) who earn more than any traditional supervisor;
- Development agencies supply modern technical equipment for drilling and blasting at nominal costs.

Under these favourable conditions a number of irrigation projects have been executed in Hunza identified by the villagers as having top priority. Within the last decade forty-eight physical infrastructure projects have been initiated which aim at the expansion and widening of existing *góčil* as well as the construction of new channels (Fig. 7.8). In addition, a few experiments have been executed with siphon (*Nasirabad*), pipe (*Kamaris*) and sprinkler (*Galapan*) irrigation. Several storage reservoirs and sedimentation tanks have been constructed as well in the productive physical infrastructure section of the Aga Khan Rural Support Programme (AKRSP). Among these projects has been the prestigious effort to free the water supply of central Hunza from total reliance on the Hassanabad glacier. The first phase of the so-called Aliabad góčil was accomplished by 1988 and it is expected that eventually 700 hectares of land will be watered from this new source (Khan 1994) and the irrigation schedule of central Hunza (Tab. 7.2) might be altered to reflect this change of supply.

This difficult project cost the loss of local farmers' lives during construction in which all concerned villages between Karimabad to Aliabad participated. If this channel will ever become sustainable—an assertion which has not yet been proven—the water deficient villages of Aliabad and Haiderabad will be in a position to irrigate all available land with sufficient quantities of water. The agricultural landscape of those villages would be effected in such a manner that present-day priority rules for crops could be totally relaxed and even marginal plots could be productively utilized. A similar judgment would apply for the remaining villages of central Hunza which would be left with a greater quantity of irrigation water from traditional sources.



Source: Aga Khan Rural Support Programme 1990

Design: H. Kreutzmann

Figure 7.8: Infrastructure projects in Hunza 1983–90.

So far, however, the new channel can only be deemed a partial success since water flow could not be sustained. Another danger lies in the channel head near the mouth of the Hassanabad glacier. Should the 16 kilometre-long glacier advance only a few hundred metres, it would destroy the channel intake which presently lies only 40 m below in vertical distance. The Aliabad góċil is a great example of a project that could not have been feasible for a village community depending on its own resources. International development aid provides a means of experimenting with new techniques and formerly unprofitable projects. If sustainable development can be envisaged, these projects will increase the agricultural resource base of this mountain valley. In case of failure, only the remuneration of the work force and the communal organizations, which have been developed, will survive. Those ruins of irrigation channels would not be the first and shall not be the last remnants of attempts to maximize the utilization of meagre natural resources in the Karakoram.

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NOTES

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2. Early appreciations of the irrigated agriculture of Northern Pakistan are found with Saunders 1983; Whiteman 1985. For the neighbouring mountain regions like the Hindukush cf. Grötzbach 1973, Patzelt and de Grancy 1978; for the Himalaya cf. Nitz 1966, Uhlig 1962. Early records of irrigation structures in the Karakoram have been collected by Lorimer 1979. Recent evaluations and analyses have been published by Charles 1985, Kreutzmann 1988, 1989, 1990, 1994.
3. The variability of precipitation in High Asia has been the topic of discussion for a long period; cf. Ferguson 1984; Flohn 1969; Haserodt 1984; Hewitt 1989. New results and calculations have been presented by Reimers 1992 and Weiers 1995. Miehe 1996, Miehe et al. 1996, and Braun 1996 investigated vegetation dynamics and potentials in relation to climatic changes in High Asia with emphasis on the Karakoram.
4. In the *wesh* system regular lotteries take place which lead to a rotation of lands among *jirga* members who safeguard maximum equitability of resource allocation; cf. for societal developments in this region Barth 1956; Janjua 1996; Jettmar 1961, 1977, 1982; Manzar Zarin and Schmidt 1984.
5. Dendrochronological evidence and ^{14}C measurements of organic matter in building materials support this hypothesis; cf. Hughes 1985; Hughes and Lefort 1986.

8

Minority Strategies to Water Access: The Dom in Hunza, Northern Areas of Pakistan[1]

Anna T. Schmid

The Karakoram Range is characterized by its extreme relief and enormous glaciation, which limit the land feasible for cultivation. Due to Hunza's position at the cross-section of the Central-Asian arid zone and the sub-tropical zone, agriculture production is only possible through irrigation and the construction of channel networks allows the cultivation of agricultural lands. Meltwater tapped below the glacial lobe is conducted to fields through a system of channels which follow contour lines along the steep cliffs. The distribution of water follows a precisely defined and mandatory code.[2]

In such a geo-ecological setting with the almost exclusive dependence of local farmers on agriculture as a basis for subsistence, water is a key factor; and the scarcity of water is the limiting factor for crop production. The allocation, distribution and supervision of water flow are the focal points of agricultural activity, leading to a variety of conflicts between different social groups, e.g. ethnic groups, villages, clans, and neighbours. In this article, I will explore one of these: a conflict between the village of the Dom, Mominabad, and a village of the Burusho, Aliabad.

The Dom form an ethnic minority which has migrated to Hunza from the South in several waves since the eighteenth century and now constitute approximately 2 per cent of the population. The Dom were settled in a separate village, Mominabad,[3] and were given land by the local ruler, called *mir* or *tham*, who in exchange for this land demanded their services as musicians and blacksmiths. The *mir* then became their protector/patron. As musicians they accompanied and constituted all cultural activities including seasonal and life-cycle festivals, shamanistic seances, and all activities of the *mir*. As blacksmiths they not only produced and maintained all

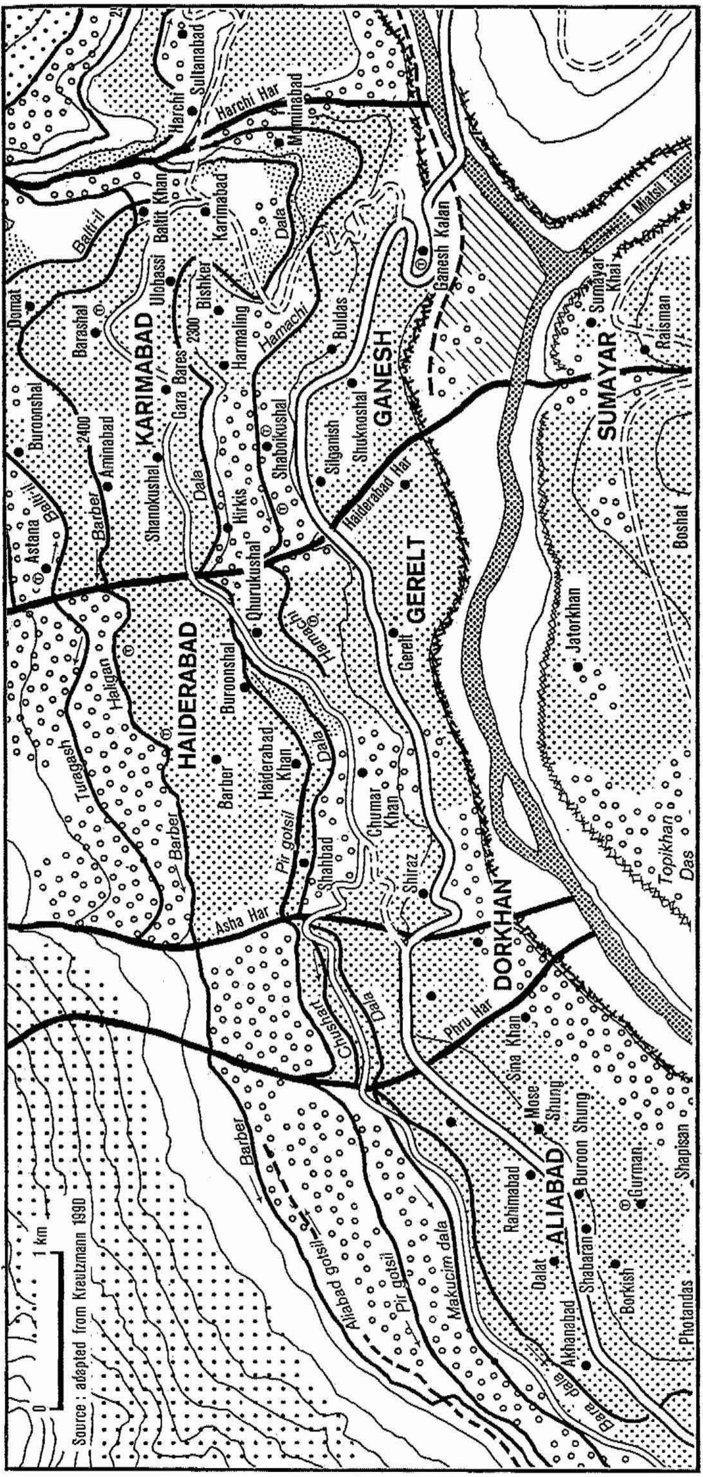

Figure 8.1: Locational overview of irrigation channels in Central Hunza (illustration adapted from Kreutzmann 1990).

agricultural implements but also acted as mediators in the religious sphere, e.g. through the fire ordeal. They currently live in Mominabad and among the neighbouring villages of the Burusho, who are the local majority, as well as with other groups, namely the Wakhis and the Shina speakers.

Their specialized professions commanded the Dom an important position within the local culture, but as artisans, they were set apart from the rest of society and categorized as its lowest social stratum. Although their primary source of income stemmed from their artisan activities, it was not enough to ensure their survival. They needed to supplement this income through agriculture. To ensure this, the Dom were successively given the necessary agricultural resources by the hereditary ruler, namely terraced fields, water rights and pasture (cf. Lorimer n.d.; Schmid 1997:115ff).

These two complementary domains—artisanship and agricultural activities—were greatly effected by several external influences: the subordination of Hunza by the British colonial administration (1891), the creation of the independent Islamic Republic of Pakistan (1947), the deposition of the hereditary ruler (1974) and finally the opening of the Karakoram Highway (1978) all affected their social, economic, political and cultural life dramatically (cf. Kreutzmann 1991:716 passim and 1993).

The most important result of these events for the Dom was the successive weakening of the *mir's* position leading to the loss of the significance of their artisanship, since the recognition of their competence as musicians and blacksmiths was mediated and guaranteed by the *mir*. Instead, their low social position was increasingly reinforced. To counter this, the Dom developed a strategy to transform their self-perception and self-image from this stigmatizing categorization as artisans to their recognition as equal members of society through an expansion of their agricultural resources. Full access to this recognized, highly valued domain—agriculture—necessitated in turn increased access to water rights. This situation forms the background for the following water dispute between the Dom and the villagers of Aliabad, the Aliabadkuts.[4]

Yet, before detailing with this specific case, the judicial system of Hunza should first be briefly outlined. As a semi-autonomous state under a hereditary ruler until 1974, Hunza had its own judicial system with different stages of appeal. At the lowest level, the conflicting parties had to negotiate among themselves to find a solution. If this could not be accomplished at the lowest level, depending on the case, the next successive stages would involve negotiation and adjudication through the heads of the concerned clans, the head of the village, and finally the Wazir. If these councils could not reconcile the conflict—a council, presided by the ruler, would decide the case definitely. In the present case, the quarrelling parties were two villages; therefore the unsuccessful management of the conflict between the two resulted in an immediate audience in front of the *mir*.

THE WATER DISPUTE

The dispute originally arose in 1965 when the Dom converted their orchards in the upper part of Mominabad above the Hamaci channel into fields, thus requiring more water for irrigation. The Dom took water from another channel, the Uyum Dala, (cf. Fig. 8.1) which they were not entitled to use. With this act they intended to press for a new agreement on water rights. In reaction to this, the rightful owners of the water, the Aliabadkuts, sanctioned the Dom, which in turn led to a hearing and discussion of the now full-blown case in front of the *mir* and his court. The case was decided in favour of the Aliabadkuts. After the dismissal of the ruler in 1974, the Dom went to court again in 1976. This time the case was tried according to Pakistani law. The case again was ultimately decided in favour of the Aliabadkuts, but only after several years of deliberations, ending effectively in 1981.

The Hamaci channel belongs to one of the three oldest channel systems of Hunza[5] and supplies Mominabad and the villages of Ganesh and its filial settlements with irrigation and drinking water. Whole villages or kinship units, such as clans, participating in the construction of a channel system will—as a general rule—receive user rights both in the cultivable land, developed and supplied by a particular channel and in the accompanying water rights. The Dom did not participate in the construction of this channel since it was built before they settled in Hunza, but the *mir* did grant them the land lying below the Hamaci; with it, they were also allocated the water rights to this area. The water is distributed as follows: of seven water lots, divided into seven days, Mominabad receives one, i.e., in one week the Dom are eligible for twenty-four hours to irrigate that part of Mominabad. To regulate the distribution of water, a precisely determined distribution system is followed and applied alternately in successive years: in Mominabad, in one year the fields are watered from east to west, in the next year from west to east.[6]

The extension of the channel system, namely the newly constructed Uyum Dala channel (also called Samarkand Khul) under the rule of *mir* Silum Khan (1790–1824) permitted not only the achievement of the primary goal—foundation of new settlements—but also the extension of the cultivable land in Mominabad. As the Dom had no labour input into the construction of this channel—"only" accompanying the construction as blacksmiths and musicians (cf. Lorimer in Müller-Stellrecht 1979: 61)—they could not claim water rights for their land above the Hamaci, except for a small field of two *marla* (approximately fifty square metres) where a special regulation was established. On this surface they could cultivate henna, which they had to deliver annually to the *mir*. For the irrigation of this field, water could be taken from the Dala starting early February.

The Dom initially maintained meadows and orchards in this part of Mominabad, for which the surplus water regularly collecting in the summer—usually starting at the end of May—was sufficient. If the water was used to prepare additional fields later in the season, the amount remaining would only be sufficient for one crop, although the Dom say the land lies in an area where two annual crops could be feasible if there was water. Since Mominabad had no water rights to the Uyum Dala, the available water was not sufficient for more than a single crop in the area above the Hamaci, and therefore the Dom had only gardens there. Under the rule of *mir* Nazim Khan (1892–1936), more Dom families had converted their orchards into fields, so that the seasonal surplus water was no longer sufficient, since the distribution key for water from the Uyum Dala channel, however, remained in force, meaning that before 20th May and from October onwards the Dom were not allowed to take water from the Uyum Dala.

DIFFERENT VOICES IN THE WATER DISPUTE

In the following I shall present the different positions taken in the dispute as voiced by the participants from both sides—Dom as well as Burusho. The detailed statements and description will reveal the various strategies applied by the Dom in the presentation of their case in front of the various judicious institutions. Secondly, it will present their perceptions of their strategies. Finally it will show how the Dom make use of and even exploit villages and kinship groups to achieve their goal.

The Case in the Court of the Hunza Principality (1965)

First, I will present the statement of an Aliabadkuts who took a prominent position in the conflict. He first recounted the case from the very beginning:[7]

> Mominabad has no property right to the Ultar-water.[8] They had a share in the Hamaci. The Bericho[9] got this part because they worked for the Ganeshkuts. Above the Hamaci the Dom only had grassland. The Aliabadkuts had to give water from the Uyum Dala, only for its use on two *marla*.
>
> Some Ganeshkuts on their way to Karimabad passed through Mominabad. The Bericho were sitting at the Hamaci, waiting for the Ganeshkuts. The *lambardar* [the village head] of Ganesh asked them: "What are you doing? Why aren't you watering your fields?" The Bericho replied: "The Aliabadkuts would punish us for it." The Ganeshkuts encouraged the Bericho: "We will talk to the *tham*, present the situation and he will talk to the Aliabadkuts. In the meanwhile you can water the fields." When the council meeting got to know that the Bericho took water from the Dala, twelve persons from Aliabad went to

> Mominabad and demanded punishment: one ox and one cow.[10] That was the retribution and then they closed the sluice. Following this, the Bericho went to the *tham* to complain; he called the Aliabadkuts and wanted to know why the retribution had been paid. The *lambardar* from Aliabad explained: "The Bericho provided *rajaaki* [forced labour for the *tham*] to the Ganeshkuts and that is why they receive water from them. They have no right to take water from the Dala, and that's why we have punished them. After the 20th May, they can get water." The *mir* then wanted to hear the position of the Bericho. They held the Ganeshkuts responsible whereupon they were called and punished. The *mir* was angry because the Ganeshkuts had encouraged the Bericho to take water from the Dala. The Aliabadkuts threatened: "Should this happen again, we will increase the retribution drastically."
>
> Then the rule of the *tham* ended [i.e. in 1974], and the elders from Hunza, the Wazir and the Bericho took the case to court [i.e. the Assistant Commissioner's office as representative of the Pakistani administration at Aliabad]. There it was also decided that they could not take water before 20th May. This is still the case until nowadays.

Then the speaker recalled vividly the situation at the meeting council:

> When the case was discussed in the council meeting, all Bericho were present. They have a special behaviour and way of acting. One Berits had a close relationship to the *tham* and went to him before the meeting to talk to him. The next day, all Bericho presented themselves before the court. Huke Berits represented them, stood up and said: "We made a mistake, that I admit, but it was only because of the village elder from Ganesh. And this mistake was punished by the Aliabadkuts." And the *lambardar* from Ganesh supported Huke Berits: "We gave them water for the fields below the Hamaci, but they need water for the fields above the Hamaci." The eldest of the other villages took the side of Aliabad: "It is our tradition, they should not use the water." But the punishment was criticized: "Why did you punish the *ustaating* [artisans]?[11] They work for Aliabad, then why this punishment?" The *lambardar* from Aliabad answered: "The *ustaating* work for Altit, for Baltit, for Ganesh[12] and for the *mir*. Do they pay in addition? Why then should the Aliabadkuts pay in addition?" The *mir* decided: "I can make no exception." He referred the Bericho to the Ganeshkuts; they should find an agreement among themselves.
>
> However, the Bericho were not satisfied with this decision. In the evening they went secretly to the *mir*. They wanted to make him revise the judgement. They brought some sheep and butter for him and for some of the elders. This bribe was the topic of discussion. The Aliabadkuts now had to monitor that part of the channel which runs through Mominabad and positioned four channel guards there. It was the time when many judgements were revised.[13] The speech of the Berits was very impressive. He wanted to attract the attention of the *mir*; it was a good tactic, a good speech. After this speech the Aliabadkuts feared that they would have to give water to the Bericho. It was a typical Bericho tactic.

> They are beggars that's why they can persuade people very well. That was the only case in which Bericho appeared before the council meeting.

The speaker starts his narrative by immediately addressing the main points without any introductory phrases. The Dom took water wrongfully, they were punished and the case has been discussed before the council. In his presentation, the speaker refers repeatedly to the economic relation between the villages of Mominabad and Ganesh. Mominabad contributed forced labour to Ganesh and, in exchange, Ganesh had to guarantee their water supply. The Ganeshkuts intervened in the conflict on behalf of the Dom, however, without success. They encouraged them to fight for more rights and promised them support, but Ganesh did not receive additional advantages such as relief from its water requirements. The motives of the Ganeshkuts lay in their becoming the advocates of the Dom, through which they hoped to gain an alliance partner. Since the Ganeshkuts are a Shiite minority in an Ismaili-dominated Hunza, they are in a disadvantaged position with regards to the distribution of forced labour assignments and representation in institutions. They felt that an alliance with another underprivileged minority could potentially have improved their position in making demands. The Dom, however, refused this alliance—not for the first time—through their public censure in the court. Since it was the Ganeshkuts who instigated their suit, they not only failed to effectively support the Dom's demand for water redistribution but also failed to gain an alliance partner. In this dispute, referring to the fission and fusion typical of village factions and the resulting conflicts, Mominabad revealed itself to be a typical village for the area.

A different type of argument is used when the Dom are characterized and spoken of as artisans. In this case, the punishment of the *ustaating* is criticized, not the punishment of the village. The Aliabadkuts are shown to resent this mixing of categories and in their arguments emphasize the village unit. The Dom on the other hand introduce their artisanal status as a strategy and use a tactic typical for them, namely their rhetorical capabilities supported by mimic and gestures, trying to influence the decision of the council first through their traditionally good relations to the *mir* and then through a bribe. The speaker explains the strategy applied by the Dom by referring to their behaviour as artisans, saying that, "it is part of their profession". The Aliabadkuts say that whenever the Dom want to achieve something—for example getting more grain for their blacksmith work or more money to perform at dance festivals—they use this tactic; namely to make a long introduction and get to the topic proper in a very roundabout way, pretending to be subservient and shameful; they hint at their miserable living conditions caused through no fault of their own and accompany their speech with forceful gestures to underline its urgency. The dramatic effect, it is said, only rarely fails to achieve its goal.

Even the Aliabadkuts feared that the Dom might achieve their desired new water rights through these means. In order to prevent this—which could still even now endanger the spoken judgement—a decision was made to apply stricter controls along the channel and as a temporary measure four more channel guards were stationed there.

From the perspective of the Dom, however, a totally different strategy for stating their case was applied. For them, the water conflict is a typical expression for the unjust and unjustified behaviour of the Burusho towards the Dom:

> The Aliabadkuts refused us a water share that was given to us by the *mir*. According to them we could not take water before 20th May. That is why there is only one harvest here. But during the rule of the *mir*, we had two harvests. Some Dom had used water from the Dala on 10th May instead of 20th May. They were punished for it: they had to give a cow and an ox. They went to the *mir*, but he decided in favour of the Aliabadkuts, who were too powerful for the *mir*. After the deposition of the *mir*, we tried to get justice from the courts and filed a case: "They refuse to give us water and our lands are drying up." The Aliabadkuts were asked to present their case and again they were favoured. "If sufficient water is there, they [the Dom] can use it before 20th May; but this has to be discussed beforehand and the Dom need the agreement of the Aliabadkuts."

According to the Dom, it was the Aliabadkuts who had changed the existing water rights. Only when the Dom defended themselves against this unilateral decision did a conflict arise. The decision ending this conflict was dictated by the supremacy of the Aliabadkuts, as alluded to in the narrative by the statement that, "they were too powerful for the *mir*". The power relations between villages and their ruler, according to the Dom's statement, are fixed, with the *mir* holding the weaker position.[14] The consequences of this weakness, in turn, negatively affected the Dom. The decision of the court is briefly mentioned but is not given much significance.[15]

In a third version of the case, the speaker, a thirty-five-year-old Dom, sees the cause for the conflict in the general political development of Hunza:

> The Dom received irrigation water from the Uyum Dala simultaneously as tenants on the *tham's* land. The Aliabadkuts stopped the water for this land and thus also for Mominabad [the little orchard with its special regulation as mentioned above]. Thus the conflict began under the rule of *mir* Jamal Khan (1945–74). Because of his regular illness he seldom resided in Hunza. Consequently he could not do anything about it.
>
> Initially, all land above the Hamaci belonged to six families from Mominabad. They could take water from the Dala for their fields. Later on, other families prepared fields there and opened the sluice without informing anybody beforehand. From Ganesh two people came and allowed the Dom to use the water: "If anything happens, we will stand by you." Then they left the sluice

> open the whole day. The Aliabadkuts punished them and took two cows. The next day, Dom who owned land in that area, came to the court. They were led by Huke Berits. The Aliabadkuts also arrived. Huke Berits presented the case and complained about the punishment. The *mir* ordered the two cows to be returned despite the wrongful use of water. But the Aliabadkuts had already slaughtered the cows. The *mir* could do nothing.

This version agrees in many points with the first version: the Dom take water wrongfully; the Ganeshkuts support them; the case is brought to the court which decides in favour of the Ganeshkuts and the punishment is criticized. A major difference, however, is that only the Dom directly concerned with the case are mentioned and the social entity "Dom", as such, is not postulated and their relations to the ruler is given prominence. It was the *mir's* weak position that enabled the Aliabadkuts to act the way they did, implying that a stronger ruler would have decided in the Dom's favour and would have arrived at a just decision. Mentioning the weakness of the ruler, the speaker refers to moral standards and their surveillance, which were formerly guaranteed by the *mir*.[16] In this case, these standards were not only changed arbitrarily, as when the situation allowed for a bribe, but were also subject to alteration through other external influences. Furthermore the last *mir*, Jamal Khan, resided often outside Hunza and thus lost much of his influence.

The Case in Court of the Government of Pakistan

After the dismissal of the ruler in 1974, Hunza was fully integrated into the Islamic Republic of Pakistan. This meant that the judicial institutions of the Government of Pakistan could be appealed to, although the newly established local councils, which practised a more or less traditional judicial system, were called on in most cases.

Since the present case had already passed through this traditional system without success, after 1976, when the last ruler had died, the Dom took the case to a public court, represented in the Northern Areas by the Pakistan Government.[17] First they took the case to the Assistant Commissioner of Hunza. They ensured the support of the previous Wazir and most of the notables of the adjacent villages to present the case with their help. The case thus gained a new dimension. In general, the judicial system was rarely and hesitantly used, since the process required the expenditure of a lot of time, money and effort. With the support of these notables, who had taken position against the Dom in the council, the possibility for them to win the case rose significantly. Above all, surprisingly, petitions had been signed by people from Baltit and Haiderabad who also gave testimony in favour of

Mominabad. These people supported the action against members of their own kinship units, since Aliabad is a filial settlement of Baltit. A rivalry arose between Baltit and Aliabad when Aliabad became the administrative centre of Hunza and Baltit partially lost its significance as the main settlement with the ruler's seat.

First the presentation of the case by the Dom as it was reported to the Assistant Commissioner in 1976 is quoted[18]:

> We request the court to take up our problem. From Harchi Har, there is a channel which flows through Mominabad, Baltit, Haiderabad, Dorkhan and Aliabad. All these villages irrigate their land from this channel. But some years ago, the Aliabadkuts forbade us to use this water. If we, despite this prohibition, use water, and we are forced to do so, they punish us. Injustice has been done to us! We are very poor people. We, the people of Mominabad, have always had access to the waters of this channel and have maintained it.[19] The people of Altit, Ganesh and Baltit are witness to this. For our labour the Aliabadkuts have never remunerated us. For this reason we request and ask you [the Assistant Commissioner], to let justice prevail and to decide in our favour that we can receive water from this channel.

To this petition was annexed the following written witness statement signed by the *lambardar* of the three original settlements (Baltit, Altit, Ganesh) and Haiderabad, the Wazir and some notables from these villages:

> We, the elders from central Hunza, swear on the Holy Koran, that the people from Mominabad use water from the Samarkand Khul [i.e. the Uyum Dala] for the land above the Hamaci. When new land was cultivated in Aliabad, the people from Mominabad continued to have the right to use this water. We, the eldest, presented this case hundred times and two hundred times the case was explained to the government [i.e. the court of the *tham*], that according to our traditions and customs the Mominabadkuts have the right to use this water. But because they are a minority, the people from Aliabad can force them to stop using the water. Again we the elders from Hunza confirm that the water from the Ultar Nala is distributed among four parties: 1. Ganesh, 2. Altit, 3. Aliabad, 4. Mominabad.[20] Because the Aliabadkuts are in a majority and stronger, they give no water to Mominabad. For this reason we ask you to act and to abolish the difficulties for the people from Mominabad. They and their children will praise you for it. The land of Mominabad along the Samarkand Khul lies fallow since five years. During these five years the people of Mominabad went hungry, they almost starved. For this reason we ask you again to give them their water rights so that they can grow wheat on these fields.

In a request for a witness statement before the Assistant Commissioner following the petition, the Mominabadkuts stated as follows:

> We, the elders from Mominabad, witness and confirm that Aliabad was cultivated under *mir* Silum Khan. Before that time, water from the Samarkand Khul had been at the disposition of Mominabad. After that, both villages used it. At the end of the rule of Jamal Khan, the people of Aliabad changed the distribution and forbade us to take water from it. During the rule of *mir* Jamal Khan, there were great problems because of this water channel. But *mir* Jamal Khan temporarily gave us water from Karimabad until he died.[21] When our state [the state of Hunza] was abolished, the case was neglected although we addressed ourselves to the government again and again in this affair. We request that the people of Mominabad be given their human rights.

Following these statements, the Aliabadkuts were asked to present their position. However, their court appearance was repeatedly postponed because they claimed to, need to participate in community labour. Finally, they gave the following statement three years later in 1979:

> We declare that the water from the Harchi Har is distributed among four parties: Altit, Ganesh, Aliabad and Akhanabad. These four parties receive water from the Harchi Har during all of the year. The people from Ganesh and Mominabad receive water for the land below the Samarkand Khul each year after 20th May. But the people from Mominabad now demand water before 20th May. This problem has been negotiated since 1965 during the rule of the *mir*, and it is still discussed.
>
> A tragedy has to be mentioned in this respect. In 1972, the people from Mominabad used the water before their time. Consequently, the people from Aliabad, according to the tradition and customs of Hunza, punished them; as punishment, two oxen were taken from them. This punishment was accepted. At that time it was decided that the people from Mominabad had no right to this water. After the 20th May, they can take water from the Samarkand for twenty-four hours per week.

In these statements, both parties reiterate their interpretation of the situation. On the one hand, both sides refer to traditional law. The Dom, supported by witnesses who contradict the statements they themselves gave in the court of the *tham*,[22] state that the distribution once favoured them, but was arbitrarily changed by the Aliabadkuts. The Aliabadkuts interpret the punishment of the Dom as confirmation that the law is in their favour. On the other hand, everyone's depiction of the case makes use of moral categories, above all in the statement of the Dom, such as: "injustice done to us"; "to be in the majority and stronger", thus using force; "difficulties" caused by the Aliabadkuts; and inferior "minority". With this depiction the Dom evoke the image of a suppressed and economically disadvantaged minority in a public institution from which they hope to "finally receive justice", appealing to perceptions of superior justice to support their formal claim.

When the first judgement was confirmed, however, they, in a last attempt, turned to the Deputy Commissioner in Gilgit in 1980:

> Respectfully we address ourselves to the Deputy Commissioner. Mominabad is a very remote area. The people of this village are technical persons and we possess only little land. Part of our land lies below the Samarkand Khul. In earlier times, only gardens were there and for them we received water from the Khul in summer. Later, we made fields there and that is why we no longer receive water. The distribution of water for this land was under the responsibility of the people from Aliabad. Until nowadays this has not been finalized and since this case is negotiated, our land has fallen barren. Against this injustice we have made many requests to the higher authorities, so far without success. Under an Islamic Government, the authorities should take care of the lower classes and suppressed people, but until today basic rights are denied to us poor and weak people. We ask you to visit our dried up fields. A decision should finally be reached and on the basis of such a decision instructions have to be given as fast as possible to prevent further damage. We often have addressed ourselves to the administrative authorities in Hunza, but these authorities respect powerful people too much and do not help us to get our rights.
>
> Four years ago, water rights were taken away from some households in Aliabad, which led to immediate action and the authorities in Hunza decided that these households have the right to use the water. The instructions issued by the authorities clarify that the water belongs to everybody and that all households can use it. No other village suffers from the denial of water rights. It is very important to come to a quick decision in this case.

Despite their drastic depiction of the situation it should be remembered that the Dom are artisans and therefore own little land;[23] this limited land cannot be fully utilized. The previous legal dealings were characterized as having failed because the judicial system bowed to powerful interests in an unequal power structure. Still, the Deputy Commissioner in Gilgit upheld the prior decisions and decided in 1981 that the Dom could not take water from the Uyum Dala before 20th May. In his decision, the final statement reads: “Should the people from Mominabad not agree or a party feels unjustly dealt with, they can go to the Civil Court and appeal. If this does not happen, the case goes to the files.”

The Dom finally had to accept this repeatedly unfavourable decision. To water the fields in the upper part of Mominabad, they now still had to divide their water share resulting in having one harvest only instead of two.

CONCLUSION: DOM STRATEGIES IN A WATER DISPUTE

Any analysis of the strategies of the Dom has to take into account both the possibly shifting alliances between groups and the ideological basis chosen for their arguments. In the following section, I distinguish between two Dom legal strategies each referring to a separate basis on which the Dom chose to formulate their demands. The first of these is an indirect strategy which asserts that since the Dom cannot rightfully claim the water quota they demand and are in no legal position to contribute to a changed legal basis, either directly through participating in a legislative council or indirectly through their own power to influence existing legislators; they have to refer to rights and positions of others and use those positions indirectly. In the above case they pursue this angle when they utilize their traditionally good social relations to the ruler as well as existing conflicts between social units—such as the one between the Shiite Ganeshkuts and the Ismaili majority—to their advantage in the court of the *tham.*

This strategy is supported by their behaviour and their specific rhetoric. They use the ascribed "Bericho-tactics" which is said to result from their professional activities and competencies: they lament loudly, approach the topic in a very circumlocutory manner and fascinate their listeners through rhetorical "tricks" and thus usually achieve their objective or at least persuade their listeners to be sympathetic. However, by applying this strategy, they find themselves in a paradoxical situation: they attempt to overcome their low social position with exactly those means which justify, in the eyes of others, their low social status. This seems to be a paradox typical and characteristic for minorities.

A second, more direct, strategy is based on the generally applied legal structure of Pakistan. They refer to Islamic perceptions of justice and egalitarian principles. They also refer to their disadvantage in the societal system as a poor, weak, suppressed group; as a class that has to defend itself against the powerful, despite their *de jure* right of equality. They attempt to set up the impression that until their appeal was made, they have been denied rights which should be generally applicable. They try to show that at least under the new government such an infamous injustice should be righted. According to their presentation, no Islamic government can ignore this principle of equality in the case of the Dom.

In this approach, the Dom have taken recourse in their specific "competence" of using conflict between opponents to further their aims. In the examples above, the Dom have been shown to be successful in getting the support of witnesses to support their positions even without much of a strong factual basis. They have gotten support even from the notables of the most important villages, who sided with the Dom after changing their own statements and position in the new legal system of the Islamic government. In this manner, the Dom also imply that existing water regulations are an instrument of exploitation targeted specifically at them.

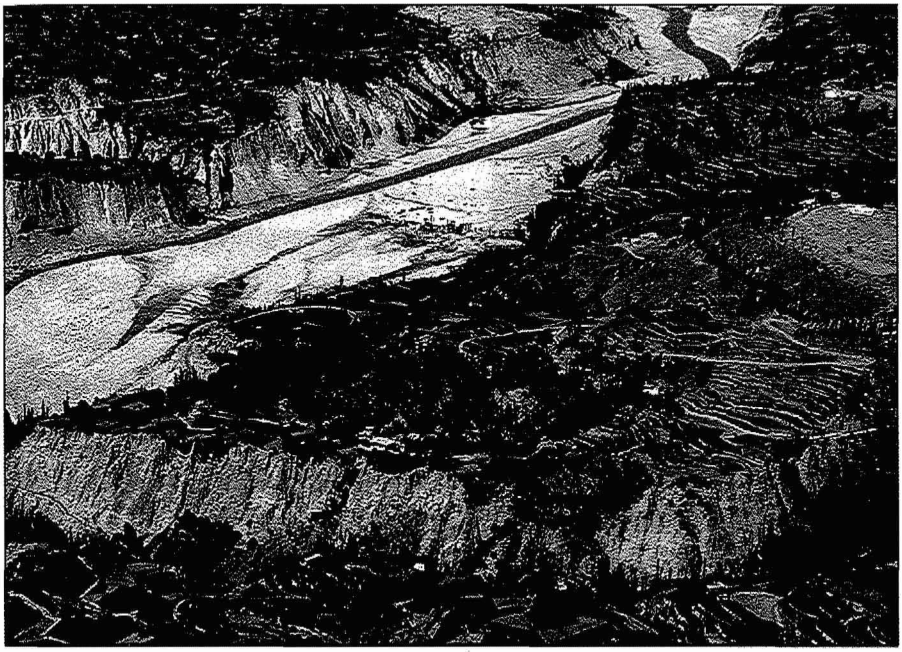

Photo 8.1: The location of Mominabad village. The Hunza River on the left and the incised Ultar ravine in the foreground emphasize the prominent locality of Mominabad in the vicinity of the former royal palace and seat of power (Anna Schmid).

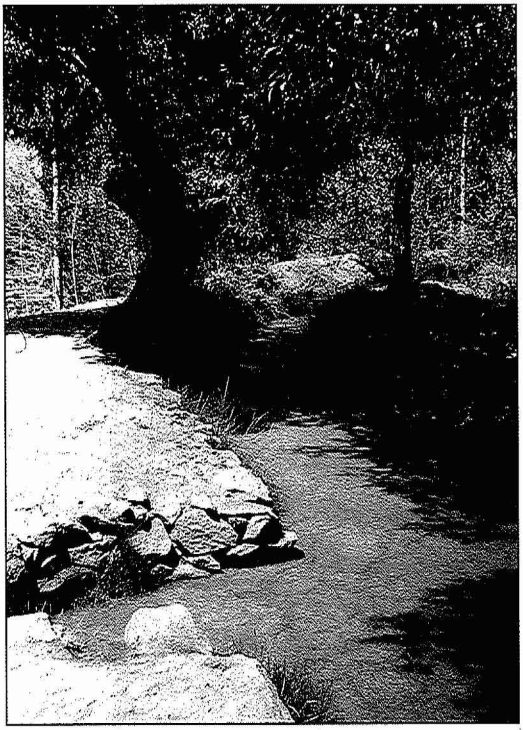

Photo 8.2: The course of the main channel (Dalá) and the sluice. The water dispute described in the text is concerned with the distribution usage in this irrigation network. Both channels (Dalá and Hamáći) are instrumentalized for the allocation of water to the village lands of Mominabad (Anna Schmid).

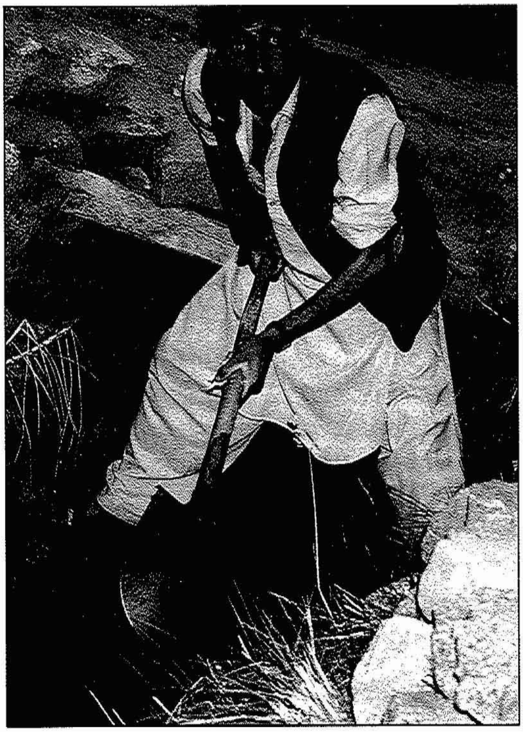

Photo 8.3: The practice of distributing irrigation water follows a codified system. Entitled users open the sluices which are closed with stones and mud when their turn is on. The schedule rotates day and night (Anna Schmid).

Both strategies of the Dom are obviously intricate and well thought out. Both use all the means at their disposal, but they still did not succeed in their appeals. Water rights represent a focal right of Hunza society and neither the ruler nor the District Commissioner can risk changing these regulations in the face of resistance from important lobbies and against customary law. Although the importance of various elements of subsistence agriculture changes and water rights are not invariable, they will not be changed arbitrarily. The main principles of water rights in Hunza, namely the necessity for share owners to have participated in channel construction; the allotment of land in combination with water rights and so on, remain conservative and continue to determine the water shares in the area.

Despite the failure in the main demand, the Dom did succeed in gaining an increased respect from those living in the area by claiming generally valid rights for themselves on all judicial levels, from the *tham*, who temporarily gives them water from his own quota, to the Government court where they are represented by the notables of Hunza and are taken seriously by the highest representatives of government power in the Northern Areas of Pakistan.

FURTHER PROSPECTS

Meanwhile, the above outlined general situation of water supply has changed. With the recently finished construction of a new channel system, the Hassanabad channel—a mammoth project which will remain vulnerable to a constant demand for maintenance and repair—has come a redistribution of water rights which eliminates water scarcity in Aliabad as well as in Mominabad for the time being. A permanent redistribution of water rights which takes these new resources into account has not yet taken place since the new channel is precariously situated which has resulted in repeated interruptions of the water supply. But if the test period for this new channel proves successful, the distribution key for all of Central Hunza has to be changed, which in turn would effect a complete change in Mominabad as well.

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NOTES

1. This article is based on material from my Ph.D. thesis (Schmid 1997). Fieldwork was conducted in 1988 and 1990 and funded by the Gottlieb Daimler-und Karl Benz-Stiftung and the South Asia Institute, University of Heidelberg which is gratefully acknowledged.
2. For a detailed description of the irrigation system in Hunza cf. Kreutzmann (1989: 79–98).
3. In 1981 the village was renamed from Berishal to Mominabad, since its inhabitants considered Berishal to be a pejorative term, whereas Mominabad, i.e. the place of the faithful, expresses their equal status in an Islamic society; cf. Schmid (1997: 106–111).
4. Besides water disputes, the most common conflicts are concerned with land and pasture rights, theft and rights of inheritance.
5. For a detailed description of the development of channel systems and water allocation for all of Hunza cf. Kreutzmann (1988: 250–253 and 1989: 80–98).
6. Concerning variations and categories of water distribution keys in Hunza, cf. the contribution of Kreutzmann in this volume.
7. Indented paragraphs are statements by participants in the case.
8. Ultar-water refers to the water received from the Ultar glacier, the main water source for the channel system under discussion. This water is distributed in the relation of 2:1:1 to three channel systems: two parts for the Uyum Dala, one part for the Hamaci, and one part for the Altit Gotsil.
9. Bericho is the formerly common name for the Dom and regarded as a pejorative term; cf. also endnote 3.
10. This form of retribution was customary; a Burusho later on explained: "The Bericho did not resist. The Aliabadkuts just went and took the animals from them."
11. When addressing a Dom directly, most often the term *ustaat* (Sg.), *ustaating* (Pl.) is used, whereas they are mostly called Bericho while talking about them.
12. Here the speaker refers to other villages of Hunza.
13. The speaker alludes to the changed situation in Hunza when judgements were revised through arbitrary interference.
14. For an explanation of the ruler's "weak position", see below.
15. This lack of emphasis is also due to the construction of a new channel, the Hassanabad channel, see below.
16. Formerly refers mainly to the time before the British occupation in 1891. Although *mir* Muhammad Nazim Khan (1892–1936) was often cited as a "strong ruler", who enforced judicial decisions and respected traditional values, Lorimer (in Müller-Stellrecht 1979: 269–274) recorded in 1934/35 severe complains about his despotism. Cf. also Kreutzmann (1989: 171–175).

17. Only after the death of *mir* Jamal Khan in 1976 the former judicial system was fully superseded.
18. I would like to thank the members of the administration in Hunza for their kind support in the research of this case.
19. This refers to one of the duties of a channel guard which partially were executed, against payment, by Dom.
20. The last statement contradicts all others mentioned so far: the water from the Ultar is distributed according to channel systems (2:1:1, as described above) and subsequently a distribution to village communities takes place. In this distribution Mominabad falls under the share for Ganesh from the Hamaci.
21. This refers to an interim solution established under the rule of *mir* Jamal Khan.
22. Whereas in the court of the local ruler it was agreed upon that the distribution of the water from the Ultar glacier was fixed and should be redefined in favor of the Dom, the statement of the Burusho before the court quoted a totally different distribution which was violated by the Aliabadkuts.
23. According to my own data land ownership for a household is 12.5 *kanal* (approx. 0.63 ha) in Mominabad, subdivided into fields (6.5 *kanal*) and gardens/irrigated meadows (6 *kanal*). In comparison, in Baltit a household owns approx. 14.4 *kanal* (approx. 0.73 ha), of which 8.1 *kanal* belong to the category of fields, 6.3 *kanal* to gardens; although land size and ownership differ little, returns can vary substantially due to water access.

9

Bridging Institutional Gaps in Irrigation Management: The Post "Ibex-Horn" Innovations in Northern Pakistan

Hussain Wali Khan & Izhar Ali Hunzai[1]

INTRODUCTION

The Focus and Scope of this Paper

This paper is about small, farmer-managed irrigation systems found in the mountainous northern regions of Pakistan. It describes and analyses the changes induced by their interface with the Aga Khan Rural Support Programme (AKRSP). In particular, it examines the relationships between participatory social organization and effective systems for local management of common village resources including land, water, and irrigation channels. The paper also explores the broader issues of policy, technology and investment in the irrigation sector, in the context of local planning and development. The primary focus is on capacity building through institutional renewal at the grassroots level. In support of this perspective, the paper presents AKRSP's cumulative experience in rural engineering and irrigation management. The evidence is drawn from 589 small, AKRSP-supported irrigation projects implemented and managed by the Village Organizations (VOs), over a ten-year period.

The Region and its Physical Environment

The area covered by AKRSP is part of the upper watershed of the Indus Basin, comprising six northernmost districts of Pakistan, namely Chitral, Gilgit, Ghizar, Baltistan, Ghanche and the Astore Valley of Diamer District. Bordering on China and Afghanistan to the Northeast and Northwest, and Kashmir to the East, the region is home to some of the highest mountains and longest glaciers on earth. Four of the world's greatest mountain ranges e.g., the Karakoram, Himalaya, Hindukush and Pamir, intersect the area. The total land area is about 74,400 square kilometres; the bulk of it is inaccessible or unsuitable for agriculture. The high mountain walls prevent the monsoon rains from reaching here from the south, making much of the inner valleys a "vertical desert" and a partial rain shadow area. Below 3000 metres, precipitation is minimal, rarely exceeding 200 millimetres annually, but at an altitude of 6000 metres and above, it could be as high as 2000 millimetres a year, mostly in the form of snow.

The physical environment is generally harsh, consisting of mountain oases, and fragile agro-ecological niches. Most of the area is over 1200 metres above sea level, where only one crop can be grown per year. Land holdings are small, averaging only 1.1 hectares, with about 20 per cent of the area under fodder and tree crops. Access to flat land adjacent to dependable water sources and difficulty of access are the principal constraints on expanding agricultural land in this area. The population of the area is estimated at approaching a million people, or roughly 100,000 families. At 3.8 per cent, the rate of population growth is amongst the highest in the world; average family size is nearly nine, and growing. Farm productivity is low due to low fertility of soils and uncertain climatic conditions—some grain varieties only just mature at higher elevations. Scarcity of fuel-wood, forage, and timber are other constraints for the people living in this fragile ecosystem.

Except in the high pastures, almost all crop production is dependent on irrigation, drawn from glaciers and snowfields, and occasionally from springs and rivers. During the hot summer season, the accelerated melting of ice and snow causes severe floods and "mud-flows", damaging irrigation channels and crops.

Traditional Systems of Irrigation Management

The region is criss-crossed with intricate irrigation channels that convey water, over scree slopes and steep mountainsides, to the nearest alluvial fans. Although, there is little documentation, the first of these channels was probably built by refugees who settled in these valleys, hiding from their persecutors from all directions. These channels were built with great skill and passion, using dry stone masonry and tools no more sophisticated than ibex horns.

With time, however, the irrigation potential that could be exploited with simple tools began to diminish. Moreover, the variability in water flow at the source put increasing pressure on the people to devise water management systems. The result, an intricate and highly complex water management system, with no single discernible pattern in evidence. Broadly speaking, title to land is usually linked to water rights, but there may be elaborate exceptions. For instance, if the land in question was historically a grazing area for an established settlement, it would not enjoy the same water rights as the mother settlement. However, this rule itself would be subject to further exceptions, depending upon the type of crops grown in a given year, seasonal fluctuation in water availability, and the round of irrigation.

In central Hunza, where water has always been a scarce resource, crops are classified, according to their relative food value, in a hierarchical order, and assigned discriminating rights for irrigation water: cereals have seniority over fodder and tree crops. This system is interspersed with a complex web of rules, procedures and exceptions that govern every aspect of water use. The measures range from rationing drinking water to determining the size of subsidiary channels that direct water to individual fields; and from measuring and controlling the flows, to making allowances for reduced snow-melt on an overcast day, all backed by sanctions enforced by the community. All sources of water are common property, and no person is allowed to build a private, subsidiary channel if there is a scarcity of water in an area.

Responsibility for water allocation, reconciliation of village disputes and maintenance of irrigation channels gradually evolved into a functional institution. The *jirga*, a body of village elders elected every year for this purpose, acts as the highest civil authority for irrigation management in a village. In case of water theft or misuse, the miscreants are fined in cash or kind. The irrigation infrastructure is treated as common property and the responsibility for its maintenance is divided and entrusted to different clans or households; each clan or household being responsible for a section of the channel.

Once a year, at the start of the agricultural season, all irrigation channels are cleaned and repaired as a regular exercise. In case of an accidental breach, the clans would pool their labour on an equal basis. In some villages, permanent *rakhas* are entrusted with daily maintenance responsibilities, including the control of water flow at the source. They are paid in grain contributed by each household at the year's end.

Subsequent phases in the construction of the irrigation channels were undertaken by the traditional rulers, or *mirs*. Both technology and the management systems were influenced by the economics and politics in each valley, and under different *mirs*. As populations grew, local rulers organized their subjects to expand the land under irrigation by building new channels. In the past, all uncultivated land belonged to the ruler. The traditional rulers granted title to anyone whom they wanted to reward, or who had resources to invest in it. Historically, investing in an irrigation channel was the principal method through which village communities claimed ownership to new land. This, naturally, contributed to increasing the state revenue in the form of compulsory agricultural taxation on individual and community holdings. Improvements in irrigation technology and management systems largely depended on the support which communities received from their respective ruler. Some farsighted rulers looked beyond their immediate domains, acquiring lands and water sources, employing both force and diplomacy.

Though most of the work was done through forced labour, the traditional system worked well because it induced collective development of large-scale projects that could not be undertaken by individual families. Another aspect of this "enforced" co-operative endeavour was that during the first few years, people who had been sent to develop new settlements by the *mir* were supported by the members of their families who had stayed behind to work their existing plots. The traditional authority and sanctions served to ensure that the lack of resources in a particular segment of the community would not be a hindrance to the development of its agricultural potential. It usually took an entire generation's effort to cut terraces from mountain slopes, to build the soils and to grow food, fodder and tree crops. The villages of Sultanabad, Oshikhandas and Mohammadabad were developed in this fashion by Hunzukutz, under the patronage of the late *mir* Nazeem Khan of Hunza.

Irrigation technology and management systems in the region have developed through centuries of trial and error, in relative isolation from the outside world. In the absence of outside knowledge and inputs, local systems were built incrementally. Many attributes of these systems are quite resilient in dealing with the peculiar problems of isolated, mountain environments. For instance, channels were constructed with the flow of water, to ensure that correct alignment and gradients were maintained. Research involved consultation with the village elders about the past movement of glaciers, avalanches and flood paths, to avoid subsequent damages to the village infrastructure. Silt-laden water was used to seal new channels, and for building soils in the new fields.

Recent History of Irrigation in the Region

By the early 1980s, the local irrigation potential had been exploited to its optimum limit, yet it remained short of achieving a new threshold without relying on outside resources and technology. Although the local systems were quite stable, they remained largely limited to maintaining the existing networks, with little or no investment in new irrigation infrastructure. In central Hunza, for instance, a major irrigation channel taken from the Hassanabad *nullah* was attempted at least three times, but without success. A few channels that were constructed by the Northern Areas Public Works Department (NAPWD), but they either did not work at all, or they soon fell into disrepair when they failed to induce community involvement in operations and maintenance. The only exceptions were those projects where the government provided expenditures for regular maintenance.

The Aga Khan Rural Support Programme (AKRSP)

AKRSP was conceived as a new approach to promoting rural and agricultural development, especially in mountain environments. It was established and is run by the Aga Khan Foundation (AKF)[2] with the support of several donor agencies. The primary objective of this initiative is to involve rural people of the area in their own development. In its first phase, AKRSP embarked on a mission to double the income of rural households in a ten-year period, which it achieved in less than six. In the second phase, AKRSP would endeavour to create permanent support structures to continue its long-term mission of institutional development. A related objective is to provide a model of rural development applicable in other, similar settings.

The principal mechanism through which AKRSP promotes its objectives is institutional renewal at the village level, by helping to create Village and Women's Organizations (VOs/WOs). All subsequent support is viewed as an investment in fostering these primary institutions. Once formed, VOs/WOs are encouraged to identify their own development needs, mobilize human and financial resources, and acquire new productive and managerial skills (Tab. 9.1).

Tab. 9.1
Village Organization (VO)

The VO is a mass coalition of all those residents of a village whose continuing economic interests are best served by organizing as an interest group. Such an organization can be created around an activity of averring importance to most of the villagers. The VO is meant to be a self-sustaining development institution at the primary village level that can enter into partnership for development with outside agencies. It meets as a general body on a regular basis so that all members can review the needs and performance of their organization. As a necessary condition, all members must make saving deposits at their regular meetings. Savings generated by individual members are the liability of the VO. The generation of capital through savings is of paramount importance to the viability of the VO, and it is used primarily as collateral for loans to finance subsequent development projects in the village.

AKRSP leverages its own resources for local capacity building, by making its support conditional upon local organization, regular savings and, where beneficial, co-operative management of common resources.

TOWARDS A NEW IRRIGATION MANAGEMENT REGIME

Investment in Institution-building

When AKRSP first came to the region in December 1982, it found the irrigation sector in a static phase. It was a time when the authority of the traditional institutions was at an all-time low, after the decline and eventual abolition of the mirdoms.[3] Old systems were dying and there were no new institutions to take their place in adding to the productive capital of the region in a continuing and systematic manner. Most villages had potentially cultivable land that could not be developed because of serious institutional gaps. The government's planning mechanisms which followed this system were too remote, both physically and institutionally, and their decisions about investments were often motivated by political considerations. Technical and economic decisions were made by the experts through distant planning channels, without consulting the intended beneficiaries.

AKRSP's response to this challenge was to formulate a concept of local development that was truly participatory, equitable and sustainable in the long term. The Village Organization (VO), built on the ashes of the old system, was intended to fill this institutional vacuum at the primary level. The new institution was a significant improvement on the traditional system which it replaced; it was broad-based and democratic, and it assumed the responsibility for comprehensive development at the village level. Moreover, it had the potential for self-reliance through gradual but systematic building of its own technical and financial resources.

Productive Physical Infrastructure (PPI)

Establishing the VOs was a relatively simple first step, after discovering the quiescent institutional gap. The real challenge was to identify productive activities that enhance the ability of the new institution to meet the development needs of its members, on a continuing basis. Here, the guiding principle was to find an activity that would encourage broad-based participation, and around which farmers could organize themselves.

Experience from around the world shows that farmers experience large increases in income as a result of improvements in their productive physical infrastructure (PPI). Thus AKRSP settled for PPI projects, both as an investment in the institution-building process, and as an entry point for subsequent development work. Based on this concept, opportunities had to be found in every village, and the process through which productive activities were identified had to be participatory.

For the purposes of creating a capacity for self-sustaining development at the village level, planning must shift from central bureaucracies to rural areas. AKRSP proceeded from the standpoint that villagers must be effective planners in their own development, and the process must draw upon the knowledge and experience of the farmers. The process of identifying projects must also be able to incorporate variations between one village and another, and sometimes within a single large village. In practice, this meant that all stages of the project development cycle should proceed through a series of interactive dialogues between villagers and the support agency (Tab. 9.2).

Tab. 9.2
Diagnostic Process: System of Dialogues

The Diagnostic Process starts with a visit to a village by the management staff of AKRSP whose residents have agreed to meet them. The General Manager or his representative initiates the First Dialogue by explaining the objectives and methods of AKRSP to the gathering. He/she then invites them to identify an income-generation project that would benefit most of the households, and that can be undertaken by the villagers themselves. Thus the purpose of the First Dialogue is to identify a PPI project, which may take several subsequent visits. This is followed by the Second Dialogue, consisting of several steps aimed at preparing the feasibility study and cost estimates. This stage involves both AKRSP's technical staff and knowledgeable villagers. The finalized scheme is taken to the villagers by the management and its cost is discussed and agreed with them. This starts the Third Dialogue in which AKRSP and the residents of the village explore the Terms of Partnership that would characterize the relationship between the two entities. At this stage, a VO is formed, consisting of all the beneficiaries of the project.

New Investments in the Irrigation Sector

Over the last ten years, AKRSP and the VOs have identified and initiated 732 irrigation channels, that account for over 52 per cent of all PPI projects supported by the Programme. These include the construction of 417 new irrigation channels and the extension and modification of 315 old channels. In addition, AKRSP has funded sixty-eight storage reservoirs, four sedimentation tanks and two mudflow control devices to improve the efficiency and quality of irrigation. Of the 732 irrigation projects, 529 were fully completed. This is the largest investment in irrigation system ever undertaken in the history of this region. The total cost of this endeavour was

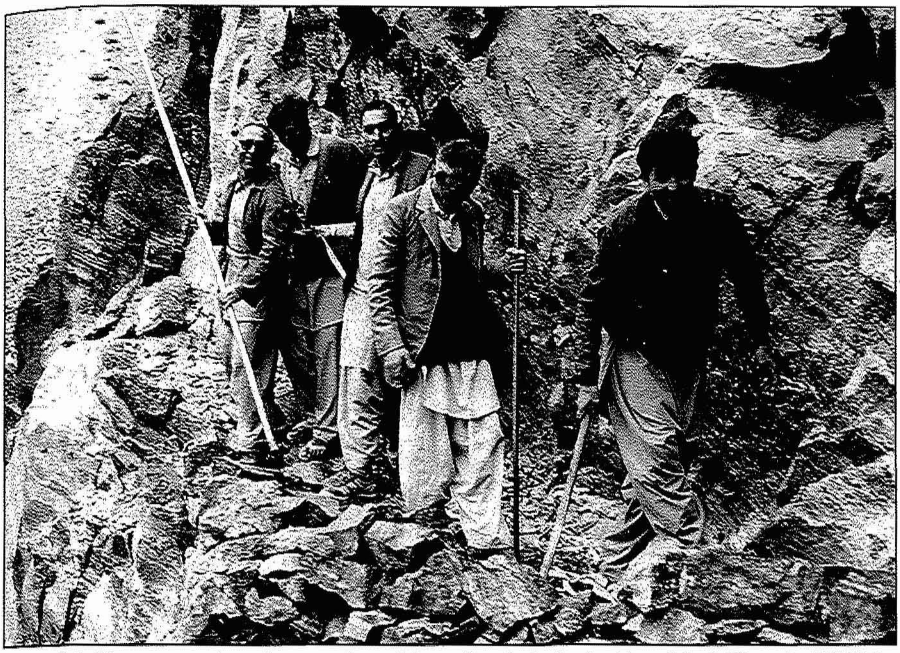

Photo 9.1: The construction of a new channel from Gurpi glacier in Ahmedabad (Hunza). AKRSP's Engineering Section supplies the village organizations with tools and expertise in order to implement new irrigation projects while the villagers provide labour (Hermann Kreutzmann).

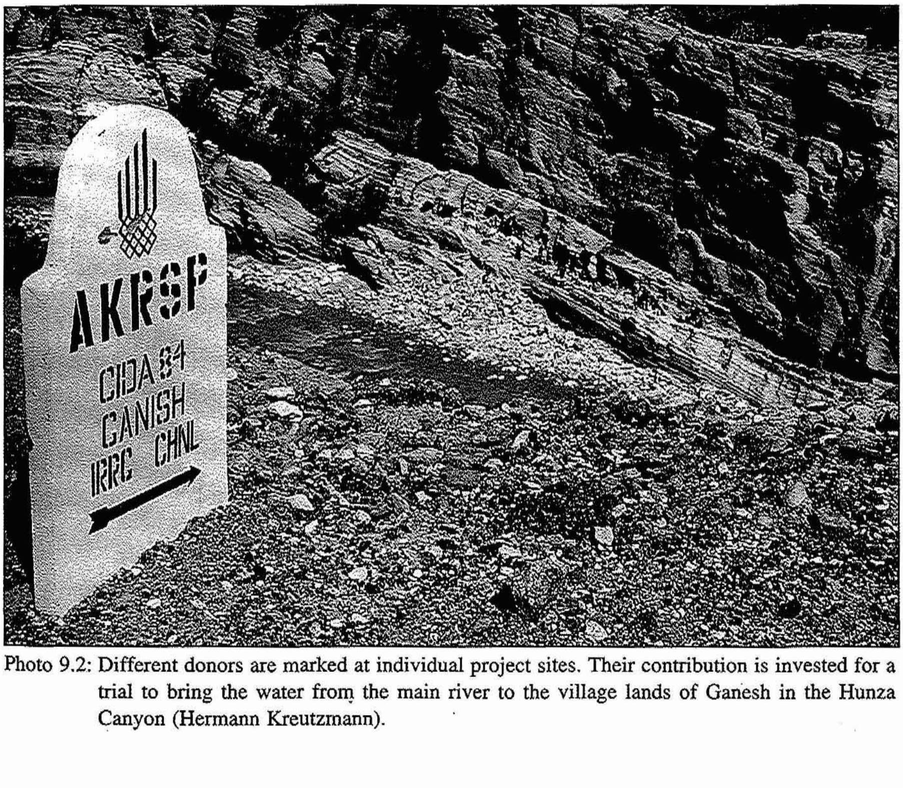

Photo 9.2: Different donors are marked at individual project sites. Their contribution is invested for a trial to bring the water from the main river to the village lands of Ganesh in the Hunza Canyon (Hermann Kreutzmann).

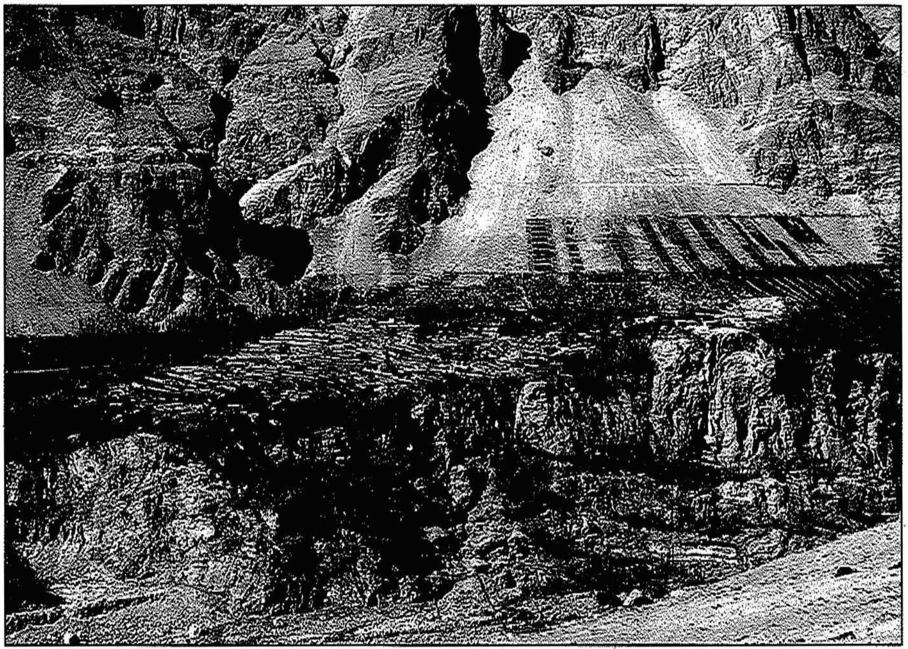

Photo 9.3a: With the help of AKRSP a steep scree slope was cultivated in Ahmedabad. Two channels were taken from Gurpi glacier. High above the traditional village lands the slope was stabilized by planting alfalfa. All contributing households received an equal share of newly cultivated land. Photo taken in April 1985 (Hermann Kreutzmann).

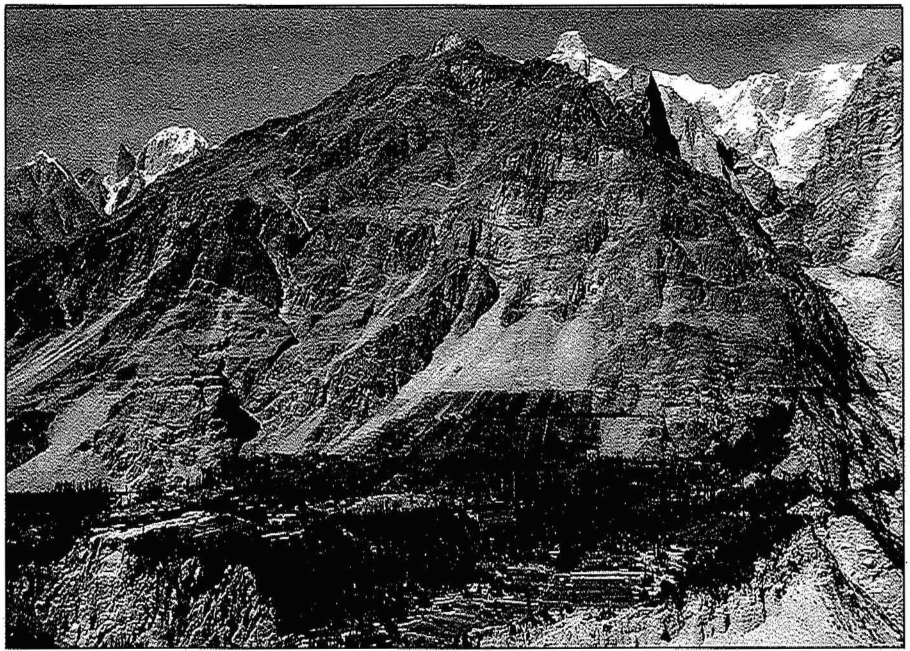

Photo 9.3b: Five years later the cultivated area has been extended substantially and different forms of crop cultivation or afforestation have been selected and tested by individual households. The maintenance of the irrigation system is organized by the village community. Photo taken in August 1990 (Hermann Kreutzmann).

Rs. 147 million, of which Rs. 127.9 million has already been disbursed to the VOs who are implementing these projects. The overall physical progress is around 73 per cent. (Tab. 9.3).

Tab. 9.3
Productive Physical Infrastructure: Number of Irrigation Projects Initiated and Completed (Cumulative as of 30 September 1993)

PPI project	Gilgit			Chitral			Baltistan			Total		
	Ini.	Comp.	%	Ini.	Comp.	%	Ini.	Comp.	%	Ini.	Comp.	%
Irrigation Channel	200	173	87	236	168	71	217	135	62	653	476	73
	(35.0)	(29.7)		(50.6)	(45.7)		(30.1)	(24.3)		(115.7)	(99.7)	
Syphon Irrigation	2	2	100	9	1	11	0	0	0	11	3	27
	(0.8)	(0.7)		(3.6)	(3.5)		(0.0)	(0.0)		(4.4)	(4.2)	
Pipe Irrigation	8	3	38	5	3	60	35	30	86	48	36	75
	(2.3)	(1.6)		(1.3)	(1.1)		(5.8)	(5.6)		(9.4)	(8.3)	
Lift Irrigation	6	4	67	2	2	100	12	8	67	20	14	70
	(2.0)	(1.6)		(0.4)	(0.3)		(2.9)	(2.8)		(5.3)	(4.7)	
Storage Reservoir	26	22	85	19	16	84	23	19	83	68	57	84
	(4.5)	(4.2)		(4.1)	(3.8)		(2.5)	(2.2)		(11.1)	(10.2)	
Sedimentation Tanks	3	2	67	1	0	0	0	0	0	4	2	50
	(0.6)	(0.4)		(0.3)	(0.2)		(0.0)	(0.0)		(0.9)	(0.6)	
Mud Flow Control	2	1	50	0	0	0	0	0	0	2	1	50
	(0.2)	(0.2)		(0.0)	(0.0)		(0.0)	(0.0)		(0.2)	(0.2)	
Total	247	207	84	272	190	70	287	192	67	806	589	73
	(45.4)	(38.4)		(60.3)	(54.6)		(41.3)	(34.9)		(147.0)	(127.9)	

Note: Upper figure indicates the number of projects while lower figure in parenthesis denotes cost in millions. % indicates physical progress.

AKRSP-funded irrigation projects are typically small, but incredibly cost-effective, and they have an immediate impact on the village economy. In addition, these projects are designed taking local conditions into account, and built with the commitment and management capacities of the villagers. These projects are implemented and maintained by the VOs without involving contractors.

Design and Survey

Initial survey and design are prepared by the AKRSP engineers in consultation with the VO members. At times it is difficult to ascertain the villagers' capacity to carryout a certain type of work, even if it is perfectly feasible from the engineering point of view. In such instances, VO members are encouraged to identify alternative projects, and select one that fits into their resources and capacity in terms of implementation and maintenance. Once a design is finalized, it is expected that the VO members will follow the specifications. However, modifications in the original design are considered if they are reasonable. It is possible that the changes recommended by the villagers may be more suitable to the local conditions. In several instances, the opinion expressed by the VO members in technical matters proved to be more viable against the judgement of AKRSP engineers. The underlying principle reinforces the view that in any meaningful development activity, the intended beneficiaries must be included in the design and survey. AKRSP's contribution in the survey and design of village level projects is only supervision and guidance in matters in which villagers find difficulties. The participation of local residents in the design has ensured a very high degree of success in these projects.

Cost-sharing and Maintenance

Every VO receives a grant from AKRSP to implement a PPI project in the village, the average cost is currently in the vicinity of Rs. 160,000. Many VOs carry out work that is over and above the specifications provided by AKRSP staff, sometimes adding 50 per cent or more to the proposed work. Moreover, most PPI projects entail the loss of some land and trees, and this cost, too, is borne by the VO. Finally, significant overheads are incurred by AKRSP staff in monitoring and supporting village-level activities, including PPI projects.

One clear indication of VOs' capacity and willingness to take on greater responsibility for their own development can be found in the maintenance of PPI projects. The traditional maintenance system of the villages has been reinforced by the presence of the VO in every village. Within the VO, each member benefiting from an irrigation channel assumes some responsibility regarding channel maintenance. Similarly, there are well laid out rules for work on a channel destroyed by avalanches or floods, and each household is expected to share equally in such work. Exceptions are made in the case of households where there are no males or where the household is too poor to contribute. In such cases, all the village households share the extra work. According to one estimate, the VOs are contributing, in maintenance services, an equivalent of Rs. 18.8 million for the annual up-keep of their newly constructed irrigation projects. The system of maintenance by the VOs is so impressive that in 1992 when unprecedented floods damaged major portions of the region's irrigation infrastructure, the Prime Minister's relief fund was routed through the VOs. By the time these funds were available, 80 per cent of the repairs were already completed by the VOs.

FINANCIAL AND ECONOMIC ANALYSIS

Cost-effectiveness

A comparison (AKRSP 1987) of AKRSP-supported irrigation channels with those of the NAPWD in Gilgit District showed very different cost-profiles.[4] The AKRSP cost per project was Rs. 136,401 and the average cost of a NAPWD channel Rs. 1.85 million. The NAPWD channels are large projects and a better comparative measure might be provided by a unit cost figure. Cost per meter of AKRSP channels was Rs. 46, while the NAPWD's cost per meter was Rs. 246. AKRSP's cost per cusec of water was Rs. 27,105 while NAPWD's cost per unit Rs. 125,196.

Economic and Environmental Impact

The payoff for small irrigation projects is of two kinds. As an entry point to further development work in the village, these projects offered as PPIs, help organize the villagers into an institution that will manage common resources more productively. The grant given by AKRSP as a one-time subsidy is also, in part, an incentive for the villagers to accept other, more advanced components of the Programme, such as regular savings, prevention of losses, utilization of credit and tree plantations. One can see the evidence of such resource leveraging in the increase of VOs' savings which now account for over Rs. 149 million.

The immediate benefit, however, is in the form of higher rural incomes resulting from the project itself. In the first instance, the infusion of capital provides temporary relief to a cash-starved village economy. Anywhere from 50 per cent to 100 per cent of the amount received by a VO for wages is deposited as savings, which serve as collateral for loans for subsequent investments. The major benefit of the PPI projects in general, and irrigation schemes in particular, is the improvement in the expansion and productivity of agricultural land and complementary assets. The increased water helps local agriculture in two ways: by providing more water for existing land, and by making it possible to bring additional land under cultivation. According to a survey conducted in 1985, approximately 56 per cent of the farmers were located in villages with *warabandi*, the practice of irrigation in turn when water is in short supply. This figure was close to the 60 per cent of villages where irrigation is the most pressing requirement. With increased water availability, the irrigation interval was reduced from 9.2 days to 7.4 days, a gain of 20 per cent in the irrigation frequency (thus no *warabandi*). The result of this survey showed an advantage of 230 kilogram/hectare in grain yields, and 760 kilogram/hectare in straw yields, among fields with no *warabandi.* This translates, in 1985 prices, into an annual benefit of Rs. 1,068/hectare in terms of wheat output alone, i.e., Rs. 45,300 per annum for a typical VO with 80 farmer-members.[5]

The impact of irrigation channels on new land for cultivation is more difficult to assess. Although the cost of channels is known, the cost of land reclamation cannot be reliably estimated in a sufficiently large and varied group of villages. However, an internal evaluation of 154 irrigation projects (Maliha Hussain et al. 1988) estimates a gross benefit/cost ratio of 2.02, and an internal rate of return (IRR) of 37 per cent, over a 21-year period.

In more conventional terms, the land which the additional water will irrigate is expected to double the existing holdings, once fully developed. The impact of this new investment on local agriculture is already evident, in changing the cropping pattern, on yields and nutrition, and for their positive effects on the environment. Based on a conservative estimate by the Forestry Section of AKRSP, more than one million trees are being planted every year by the VOs, and their survival rate is over 90 per cent.

CRITICAL SUCCESS FACTORS

Innovation and Learning

Though not directly involved in the actual undertaking, AKRSP's Engineering Section works side by side with the VOs in survey, design, implementation and maintenance of irrigation projects. The idea is to graft modern engineering knowledge and expertise onto local skills. Thus the whole endeavour becomes a partnership to pool resources and skills to achieve the best possible results.

AKRSP encourages labour-intensive irrigation projects that are not only doable and manageable by the local communities, but that also bring the much-needed cash into the village. Another aspect of this practice is even more interesting, and that has to do with building co-operative spirit among VO members, as well as hands-on training in project management.

The use of new technology is also encouraged on a selective basis. For instance, AKRSP has introduced portable drill machines with built-in engines. These machines are ideal for the peculiar conditions of this region, which often allow little working space for picking away at obstructing rock formations. Compressors and explosives are other technological inputs provided by AKRSP for effective excavation. In all cases, VO members are given training in the use of new technology as part of the assistance package.

AKRSP's Engineering Section is also involved in adaptive research, especially focusing on the traditional techniques, rather than applying textbook formulas. Research has been conducted on existing channels to determine discharge and velocity as well as determining engineering constants. This was particularly necessary since there is not much literature available in relation to local conditions.

Meaningful Participation

With villagers identifying and implementing their own development projects, significant elements of community participation are automatically introduced. Firstly, knowledgeable villagers are intimately involved in the survey and design of their projects. This increases their interest in the success of village projects. The implementation phase also serves as an important exercise for the villagers to put their ideas and energies together, and to increase their technical and managerial capability. Secondly, villagers are encouraged to save part of labour cost disbursed for the project. This means that while constructing a productive physical project, they are also creating a common financial asset. Thirdly, all transactions are kept transparent. During the "third dialogue", cost items are individually discussed in the presence of all the members when the project is finally approved and the first instalment is paid to the VO. Finally, the community implementing the project has to demonstrate the willingness and ability to maintain the project after completion.

Re-defining Self-help

AKRSP's definition of self-help is neither limited to the physical labour component, nor to the provision of free labour as such. In AKRSP's view, self-help translates into the willingness on the part of the villagers to organize themselves and embrace the responsibility of co-operative management. From this perspective, the concept of self-help encompasses the entire programme which calls for a development partnership between AKRSP and the VOs. The myth has to be dispelled that voluntary labour is "free". It may be free from the point of view of agencies involved in undertaking a project, but in a real economic sense, farmer's time can never be free. Nor does "free labour" ensure the viability of a development *process,* even if it helps in the implementation of a specific project.

The point needs reiteration that, when the objective is to initiate a development process with a perpetual momentum, the foremost pre-requisite is the establishment of an institution, village by village, which enables individual farmers to function as a single unified entity with an adequate capacity to raise its own capital, identify its priorities and then, accordingly implement and maintain that infrastructure. This is the essence of self-help, and VOs are the realization of this concept. AKRSP's point of departure from other development agencies is that it considers the provision of necessary initial capital and technical assistance as the foremost responsibility of a support mechanism, like itself.

Considerations of Equity

Equitable distribution of benefits and obligations is a key pre-requisite for a VO to obtain assistance from AKRSP. In the case of irrigation channels, there are issues of equity in the construction and maintenance of the projects, in the distribution of water rights, and in the division of the new land in the command area. AKRSP has helped to ensure equity during construction by encouraging the entire village community to participate. However, the exact manner in which this is achieved is primarily left to the VO. AKRSP withholds its co-operation from VOs which are unable to resolve their internal disputes through discussion and dialogue. As recalled in section 2.5, the VO has strengthened the traditional system of maintenance by imposing sanctions itself, or by supporting the sanctioning role of traditional institutions where they exist.

In most parts of the region, landholdings are fairly equally distributed. Thus water is also relatively equally distributed as households do not vary much in their cropping decisions within villages. In accordance with age-old custom, new land is divided equally among all existing households, either before reclamation, or after. In exceptional cases, landless households, who are a very small proportion of the local population, also get a share of the potentially cultivable land. In apportioning new land, various factors are considered, such as the quality of soils, accessibility, topography and potential cropping. Thus, a farmer getting a plot of land that has poor soil will generally get a larger share than a farmer who receives better quality land. To make the system even fairer, lots are drawn to determine who will get which plot. The system is perceived as fair by everyone.

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NOTES

1. The authors have been General Manager and Programme Manager (HRD), respectively, of the Aga Khan Rural Support Programme. Much of what they have written here imitates or is inspired by the work of Shoaib Sultan Khan, the founding General Manager of AKRSP, to whom the authors owe a deep and lasting intellectual debt. Shoaib Sultan Khan is now a Senior Advisor to the UNDP.
2. AKF is a private, non-denominational philanthropic network established by His Highness the Aga Khan. It seeks to develop social development, primarily in low-income countries of Asia and Africa, and works with all people without any kind of discrimination.
3. Hunza was the last of such autonomous states to be incorporated in the federation of Pakistan, in 1974, cf. Kreutzmann 1993, 1995.
4. Maliha Hussein et al. 1988.
5. Differences in inputs other than water were not statistically significant. Source: Wheat Crop-cut Survey by Tariq Hussian; AKRSP. Gilgit 1985.

10

Notes on Irrigation and the Legal System in Ladakh: The Buddhist 'Brog-pa

Rohit Vohra

INTRODUCTION: TOPOGRAPHICAL AND CLIMATIC DETERMINANTS AFFECTING IRRIGATION AND AGRICULTURE

Ladakh occupies the grid 32° 15' N to 36° N latitude and 75° 15'E to 80° E longitude, covering an area of 95,876 square kilometres, with the Karakoram range forming the northern geographical boundary. The Ladakh and Zanskar ranges traverse in a south-easternly and north-westernly direction separating the Nubra and the Zanskar regions respectively from Central Ladakh. In the south, Zanskar is bordered by the northern face of the Great Himalayan range. In general, this is an elevated region where mountain ranges are interspersed by valleys except in the east where lies the Chang-thang plateau. These mountain ranges are a steep, rocky terrain where top soil is either entirely absent or, if available, it is too thin to sustain agriculture.

Despite the large territorial expanse of Ladakh, the total cultivated area was only 16,000 hectares according to the Draft of the Fourth Five Year Plan for Ladakh District. Agriculture is undertaken at the height of 2700 to 4500 metres, along the banks of streams and rivulets and around springs where there are alluvial deposits. The main agricultural activity takes place in the temperate zone (2700–3600 metres), while in the high alpine regions (3600–4500 metres (Dendaletche 1985, Tab. 6), one fast growing variety of crop is sown along with livestock herding. In the temperate zone, it is mainly along the gentler slopes and alluvial fans that in cutting terraces for fields makes cultivation possible. Sometimes even two crops can be harvested. This second crop is usually a fast ripening variety of pea or buckwheat, although this latter is mostly restricted to areas in Nubra (Vohra 1985a: 247–248) and the north-western part of Ladakh, principally along

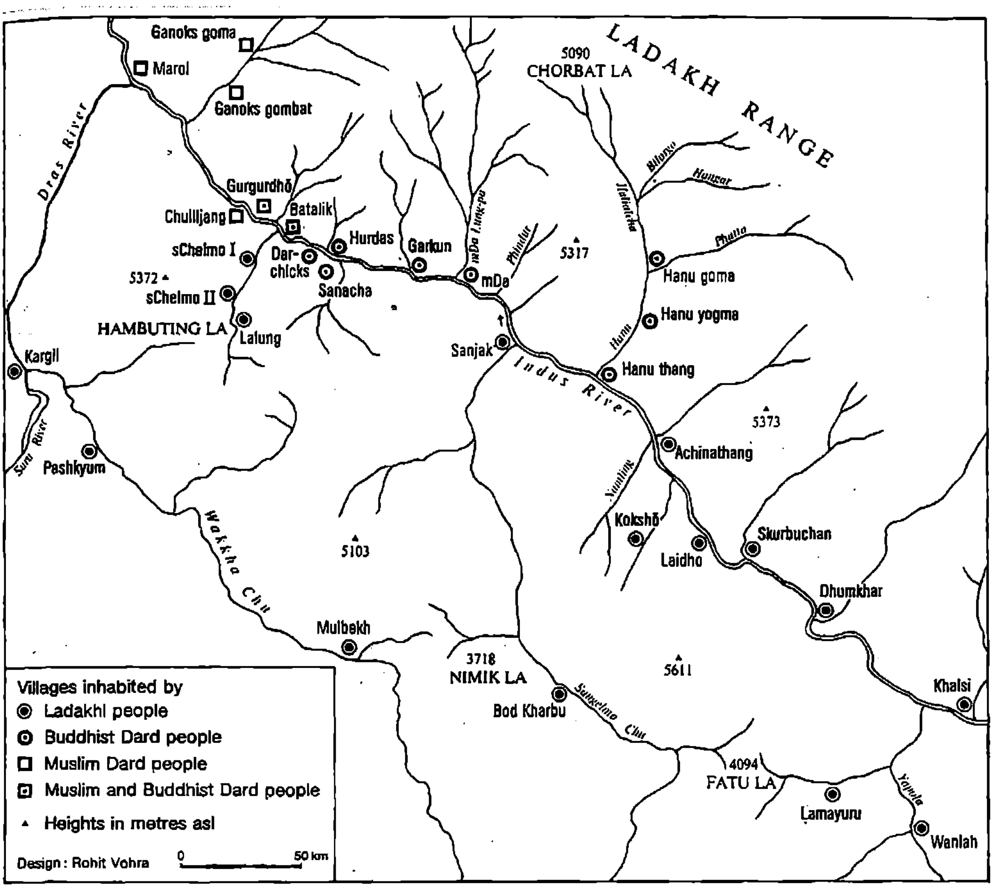

Figure 10.1: Map of the Indus Valley.

the lower Indus, which are warmer and more fertile. Each region and often each valley, however, has its own characteristics and micro-climatic features, each requiring individual solutions.

In Zanskar, for example, the agricultural zone is restricted to between 3500 to 4300 metres (Shadi village; Osmaston 1985: 76). This regional diversity is highlighted by Schweinfurth in his paper on the Nanga Parbat area (Schweinfurth 1983: 536–553). Under the ecological conditions prevailing in Ladakh, elements of climate like temperature and precipitation play a major role in agriculture and highlight the role of irrigation.

Temperatures

Temperatures in Ladakh fall very low in winter. The Dras area records the lowest levels, often 30° centigrade below freezing. The cultivation season, which generally extends from March-April to September, varies from year to year depending upon thawing conditions. This period is slightly longer in the above mentioned warmer areas. The ripening of the crop is further affected by daily temperature fluctuation, which in the warmest months may rise to +30° centigrade, but drop to +10° centigrade during the night.[1]

Precipitation

Precipitation in Ladakh generally does not rise above ninety millimetres per annum, but this precipitation level is not applicable to the west and north-western parts, where it nearly doubles. It is even higher around Dras. The higher precipitation of the Dras area (3066 metres) is due to its geographical situation, surrounded by mountain ranges themselves receiving a great deal of precipitation. A comparison of the precipitation levels gives a sense of the variation, with: Leh at 45 millimetres, Kargil at 225 millimetres and Dras at 535 millimetres in 1981 (Osmaston, Frazer and Crook 1994: 42; and also see Records Meteorological Observatory, Government of India).

Precipitation is mainly in the form of snow from December to May, but during the main agricultural season it is not much different from other areas of Ladakh. The majority of precipitation is in the form of snow and is vital at the beginning of the agricultural season. Early thawing is achieved by spreading animal dung and human faeces (Friedl 1983: 49; Dollfus 1989: 27) mixed with hay and earth, over the snow-covered fields, to enable the fields to absorb the water. The main agricultural season is dry, however, with little or no precipitation of any consequence. Even irrigation water derived from melting snow and ice in the heights, evaporates due to the extremely high day temperature.

From the above two factors, we can gauge the importance of irrigation for the functioning of the agricultural process. Not only are water resources scarce in Ladakh, but they have to be channelled through an ingenious system of canals, a task which is tedious and extremely laborious. Thus, one finds that even though arable land is scarce, water is even scarcer due to the sandy nature of the soil and under these arid conditions the irrigated oases represent a cultivable area requiring intensive labour for its maintenance.

INTRODUCTION TO THE BUDDHIST 'BROG-PA[2] OF LADAKH

Ethnically the Ladakhi population and culture forms part of the Tibetan sphere of influence. Over the past millennium, however, migrations as well as the interchange of ideas, from neighbouring Baltistan and Gilgit, above all, have provided Ladakh its own particular identity. This intermingling is highlighted specially in the Purig area where we find ethnically pure pockets of Balti (villagers of Karkechu, Hardas, Lathouthalo and Baragaon close to Kargil) and Buddhist 'Brog-pa Dard villages preserved. The Buddhist 'Brog-pa Dard claim descent from Gilgit, and have preserved traditions for almost 800 years, when their earliest ancestors migrated along the Indus river to the north-western corner of Ladakh. The other members of the Dard ethnic community are all Muslim[3] (Vohra 1983a), and have often been associated with the Daradas of Sanskritic literature (Vohra 1983: 53–66). The Buddhist 'Brog-pa have preserved some of the most archaic Indo-Aryan traditions. Having been converted to Buddhism just over a century ago, they have continued their language, religion, cultural traditions, and way of life as before, but with a sprinkling of Buddhist ritual.

In this 'Brog-pa area of mDa-Hanu-Garkun, villages remained independent valley republics under their own chieftains. The remote, wide glacial valleys in the upper mountain regions, inaccessible except through narrow passes cut by the mountain streams which flow down to join the Indus, provided natural protection for the survival of these "acephalous village republics". These villages were characterized by a grass-root level socio-religious organization, often under charismatic leadership of local 'warrior heroes' who led raiding expeditions and conquests. This independence was characterized by semi-acknowledgement of the overarching protective authority of the neighbouring sovereign. This is revealed in their folklore and hymns, where not only are their own chiefs revered, but where they relate how they allied themselves either with the rulers of Skardu or Ladakh over the past few centuries (Vohra 1989, 1989a).

Early Traditions: Case Study of the 'Brog-pa Village of mDa

The early traditions of the Buddhist 'Brog-pa show the importance of irrigation in the establishment of a settlement. It is recounted that the three brothers from a Gilgit-pa household came hunting and were successful in their hunt in the mDa pasture area ('Brog-skat, the language of the 'Brog-pa: *mDa 'brog*). That evening, when they settled down to sleep, several grains of barley fell out of the straw stuffing in their shoes (*Krat-pa*). Back in Gilgit, once their meat supplies had been exhausted, they remembered once more the *mDa 'brog* area with its bounty of wildlife. Upon their return there the following year, they found that the grains of barley they had dropped had flourished and bore ripe ears of grain, which proved the fertility of the soil. When they finally returned to the area with their families, having decided to settle there, however, the first and most important activity was to establish an irrigation canal as recounted below.

> The three brothers Dulo, Galo and Melo of a Gilgit-pa household having arrived at mDa 'brog, roamed the surrounding area and found level ground at the junction of the mDa stream with the river Indus. An irrigation canal had to be dug in order to cultivate this land, but due to the location of the land and the lack of implements, they had to think up a scheme. The youngest brother soon provided the solution by suggesting that they shoot an arrow and the spot where the arrow landed would be the place to start digging the canal.[4] There is an elevated area called Changlota between mDa 'brog and Shanglo from where the eldest brother shot an arrow. The arrow hit a rock causing water to burst forth and the three brothers went to the site and began excavating a canal, using a wooden spade (*purcha*) to dig out the earth and the horns of a goat to remove the stones. (Vohra 1982: 72–76)

This spot was shown to me as evidence of the truth of their folk traditions. It is the place from where the canal emerges, diverting the waters of the mDa stream to irrigate the fields of the present settlement.

'Brog-pa Traditional Land Holding System

The traditional 'Brog-pa land holding system provided flexibility of adaptation to the demographic fluctuations over generations within a household. The cultivated fields in the village of mDa, according to local tradition, were communally owned by each *pha-spun* group[5] of the village from the earliest times. The total number of households in the village were divided into five to six *pha-spun* groupings, each *pha-spun* grouping having between five to seven households as members. Each household, identified within the village by a particular house name (*ghota-nü*), went through mutations but never bifurcation (i.e. establishment of a neolocal residence). Thus, in each succeeding generation, the eldest son became the new household head replacing his father.

The amount of land cultivated by each household within each *pha-spun* varied from generation to generation and was periodically re-divided as the number of household members increased or decreased (Vohra 1989a: 19–26). As the amount of cultivated land available is directly related to the availability of water and the possibility of constructing irrigation canals in an area, land holdings are limited; yet a household might require more or less land depending on the fluctuation in the number of their births and deaths and the respective increase or decrease in their working and consuming members. Moreover, irrigation is a labour intensive process in a mountainous area. Thus, the number of fields that can be managed by a household is directly related to the number of working hands. Irrigation canals require repair at the beginning of each season and maintenance throughout the agricultural season. As water is supplied to the fields in turn

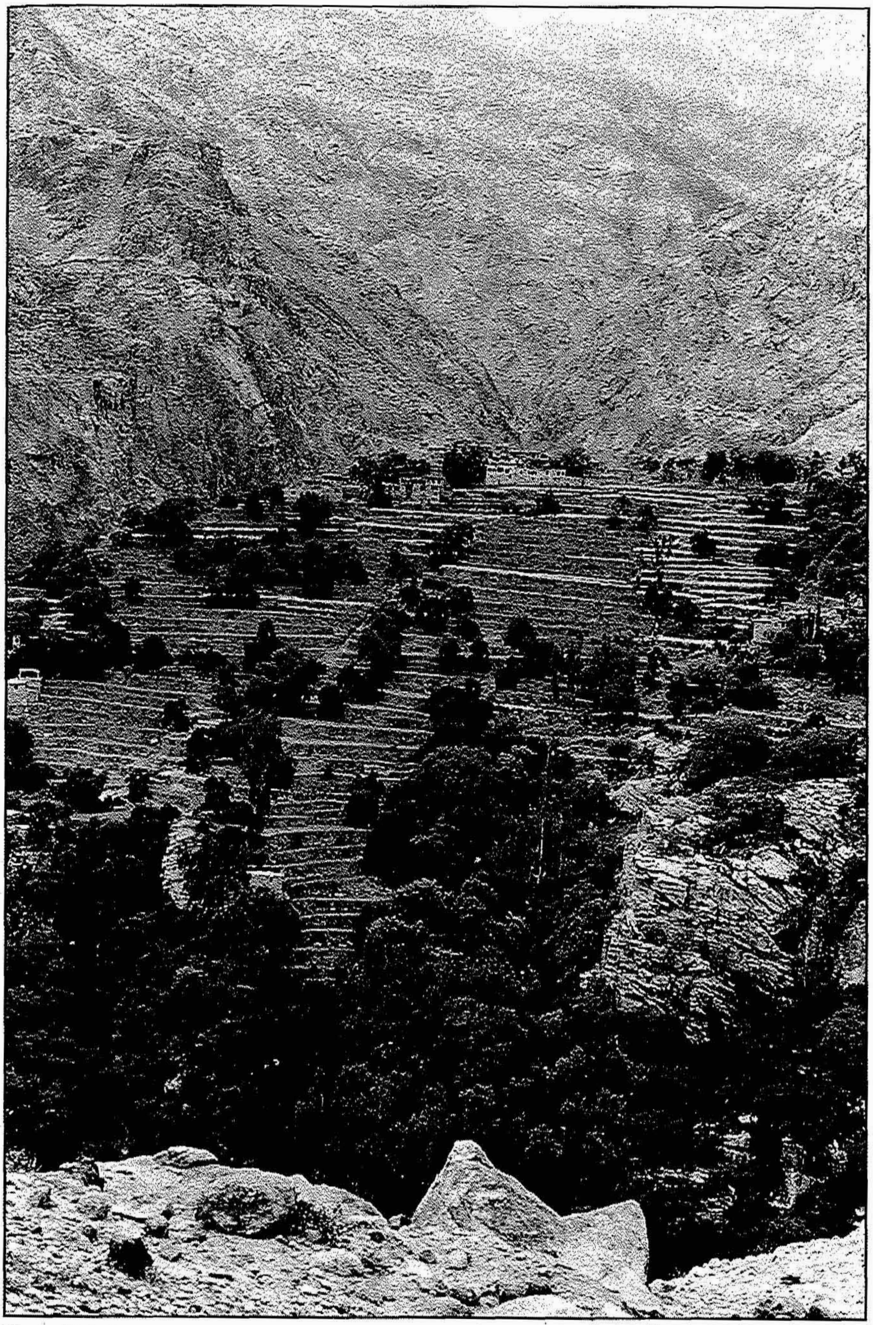

Photo 10.1: Indus valley, terraced fields and village of Darchicks (Rohit Vohra 1980).

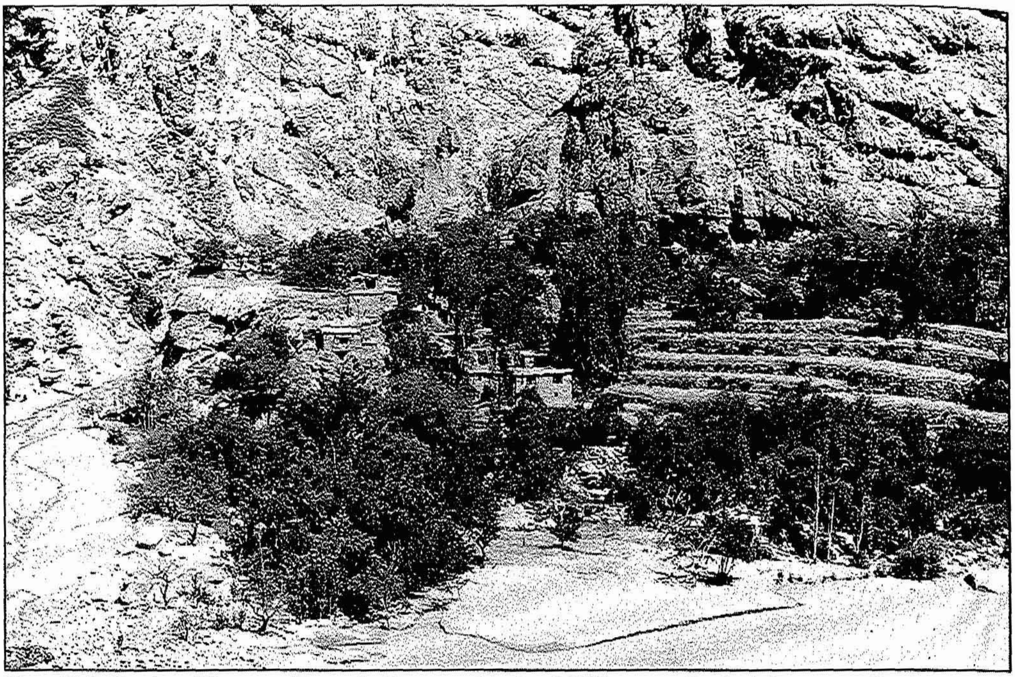

Photo 10.2: Hamlet of Byema, village of mDa at an altitude of 3200 metres. On the left a stream flowing towards the Indus (Summer 1980, Rohit Vohra).

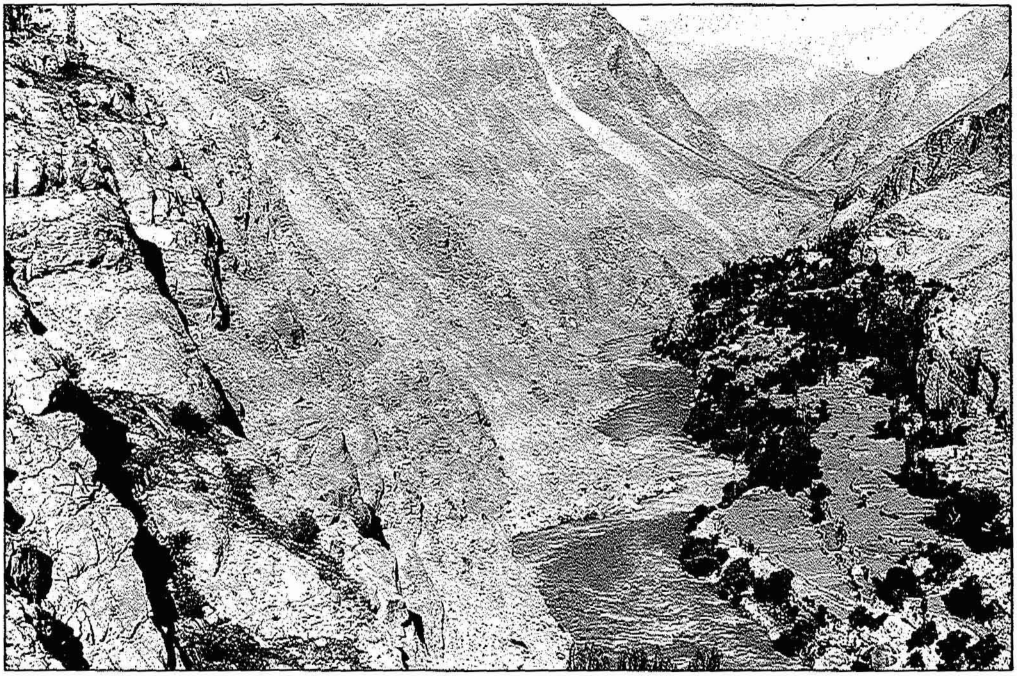

Photo 10.3: Hamlet Sanid, village of mDa. Terraced fields amidst river Indus on the left and rocky defiles on the mountain on the right (Summer 1980, Rohit Vohra).

on a daily basis, each household must be prepared to receive its water and finish irrigating its fields on a particular day. This often involves watering fields late into the night to complete the work in time. Furthermore, irrigation work requires constant care, since too much water could wash away the top soil and ruin the crop, if not the field. The traditional land holding system, therefore, included a provision for the possible "redistribution" of land every few generations if the need arose. Land rights were therefore not in the name of individual households or families.

With the Land Settlement Act[6] in 1908, the land, or rather the fields were registered in the name of each household as they were found distributed during that year within each *pha-spun*; this finished the traditional land redistribution system. With this registration, the households were obliged to pay taxes on their land holdings. This also altered the land holding system which was dependant, in turn, upon the irrigation facilities available to a village community as a whole. In the case of the rest of Ladakh, taxation was known under the reign of the rGyal-po[7], the local rulers, and this was continued under the Dogra governors[8] with slight alterations. The British, successors of the Dogras, further improved upon the taxation system until the initial implementation of the Land Settlement Act in 1901.

Classification of Land and Registration of Sources of Irrigation Implemented According to the Land Settlement Act

The Records of Rights were prepared by recording the specific types of land and sources of irrigation as required by the Land Settlement Act for the purpose of taxation.

Classification of Land

The land was categorized into three classes: Majing, Barjing and Thajing, the best being Majing and the least favoured as to quality being Thajing. The prefix Bagh was added wherever any of these three types of land were planted with fruit trees: thus Bagh-Majing (in Urdu *bagh* means a garden). Land left fallow for a period of three years was known as Banjar Jadit, and land left fallow for more than three years was called Banjar Kadim. Land which was not arable, either because it was too rocky or because it was built upon was known as Gehr mumkin. Land upon which poplar trees were grown was known as Sapedahzar (Urdu for white poplars) Banjar Kadim. Land used for the cultivation of vegetables was called Chass, while land upon which grass was grown for winter fodder was called Öl-thang.

Land owned by the government was partially measured, but also included unmeasured areas. The village as a whole was allowed to graze their livestock[9], build their houses and plant trees on the measured land. In the case of village mDa, land along the Duan stream remained unmeasured and was open for grazing the livestock of both the villagers of mDa and neighbouring Garkun. Cultivated land was often in the form of terraced fields supported by stone walls. It was the responsibility of the owner of the field above to repair the wall and provide compensation for any damage if a wall broke and stones fell on a lower field. The grass growing on the boundary dividing two fields was to be shared equally by the owners of the fields.

Sources of Irrigation

The mDa stream (Tokpo mDa Bar) originates from the glacial heights of the Ladakh range, about two days' journey on foot. The other streams are Tokpo Kiskis, Tokpo Dundur Bar and Tokpo Chander Bar. These are the streams from which irrigation water is diverted. There are also four natural springs (locally pronounced *chumik*) which provide water for irrigation to mDa: Chumik Cham cheng, Chumik Paljor, Chumik Bélash and Chumik Sant Lumba. During the night the water is stored in five water tanks, used during the day for irrigation purposes.

PRESENT TRADITIONS REGARDING IRRIGATION AND AGRICULTURE

Present irrigation and agriculture customs have an ancient origin as revealed by the 'Brog-pa hymns (Vohra 1989, 1989a). Over time, these traditions were adapted to changing conditions, particularly during the last century when administrative reforms were introduced by the British.

Bahiz: The Irrigation Festival and Existing Customs Regarding Irrigation

Bahiz is the festival associated with irrigation which forms part of a series of festivals linked to the agricultural cycle. Along with the ploughing, maintenance is carried out on the supporting walls of the terraced fields which require a great deal of upkeep. Stones lying around in the fields are removed and collected along the water canals to be used later to regulate the flow of water into the fields. Earth and manure mixed with chaff is used in the fields to revitalize the soil. The canals connecting the fields are cleaned and similarly repaired. The *Chur-pun* (Tibetan: *chu* = water; *dpon* = chief of), who is responsible for regulating the water supply to the fields of each household, is also responsible for the maintenance of the canals.

A few days later, the first ploughing ceremony, the festival Bhi, initiates the tilling of the fields by the villagers. The *La-bdag* (Tibetan: Lha-bdag; protector of the deities; priest) from Gangeldé-pa household irrigates one field, thus beginning Bahiz. In case a new canal has to be dug, a special ceremony is first performed whereby prayers along with salted grains, which are regarded pure, are offered by the *La-bdag* to the goddess Gangsi Lha-mo.[10] Only after this can excavation for the new canal begin.

In Garkun the *La-bdag* responsible for serving the deities during the festivals comes from the Golo-pa household of Sumen-pa *pha-spun*. The *La-bdag* who is responsible for Bahiz, (i.e. inaugurating the irrigation at the beginning of each season), on the other hand, comes from the Kamber-pa household of Chalo-pa *pha-spun* in Garkun village. In mDa village, the offerings to the deity Gang-si Lha-mo during the inauguration ceremony are performed by the *La-bdag* from Gangeldé-pa household of Lalüshé *pha-spun* (Tab. 10.1). Nowadays the local Lama also reads the prayer '*sna rgyat*' (Tib: *nam-sa-nam-rgyad*) at the beginning of Bahiz.

Tab. 10.1
Agricultural festivals in the 'Brog-pa villages

Festival	Occasion	app.date
Speeches	change of season	15th January
Bhi	sowing of crops (Ladakhi: *sakka*)	end of February and beginning of March
Sontans	prayer for a successful crop	one week after *Bhi*
Bahiz	irrigation festival	15th march
Nah	harvest festival (Ladakhi: *shrubla*)	end of June and first week of July
Khudaskhal	threshing of the crop	mid-August
Bononah[a)]	harvest festival	triennially celebrated

a) This Festival ('Brog-skad: *bono* = big; *nah* = harvest) is also known as *Chupo Shrubla*, where their archaic traditions are reactivated once in three years and deities worshipped who do not play any role in their daily life (Vohra 1989: 77–96; 1992: 83–108).
Source: adapted from Vohra 1992: 131–133

Once Bahiz has been celebrated, the irrigation of the fields can begin. Water originating from certain streams, glaciers, ponds and fresh water springs is judiciously divided among the fields of the villagers. A detailed record with drawings of the region's water sources and supply is kept in the Leh archives[11], the earliest having been prepared at the turn of the century at the time of the Land Settlement Act.

The distribution of water is set according to the days of the week and each household must await its turn to water its fields. The fields located higher up receive water first and it is distributed subsequently to those lower down and so it rotates through the week. Some of the water canals also form paths and alleys in the village when they are not being used for irrigation purposes, but on particular days water flows down one of these alleys indicating whose turn it is to water the field. The loan of water to a fellow villager who may be in greater need on a particular day is not uncommon and the favour is returned on another day.

Canal repair work requires a lot of wood each season and the *La-bdag* decides which tree is best for the required purpose. The *La-bdag* chooses one from among the trees growing along the canals and no compensation is made to the villager whose tree it might be. Wood is used in several ways in canal repair work, but its main use is to bridge two places and make an aqueduct with the hollowed tree trunk.

The regular watering of the cereals begins approximately one month after they have been sown. The watering of the grass follows a week later. Following this, weeding and watering of the fields continue on alternate weeks until the harvesting of the crop.

After the celebration of sGunla in early June, when the livestock has been sent to the higher valley pasture grounds, the villagers concentrate on the crop which is to be harvested the next month. The crop at this stage requires a great deal of attention and the watering of the fields has to be very scientifically managed. As the fields are terraced, water flow has to be controlled as too much water can wash away the soil and damage the crop. Water is only allowed to flow in small quantities as the soil is not very deep. Mud dams are built up within the fields to retain the water and allow an even soaking of the soil. Often the women carry out this work until late into the night as the distribution of the water supply among the villagers requires each household to finish irrigating its fields on its specific day.

The technical elements of the irrigation system, the diversion of water from a particular source and its construction all have been cause for particular notice in western literature since the Moravian missionaries first entered Ladakh and attributed the system to the 'Brog-pa Dards (Francke 1907: 19 passim; Ribbach 1940: 30–32, f.n.12).

Taboos Connected with Water and Irrigation Canals

Within the village the father of the newborn child must not approach a freshwater spring or cross a stream for the period of one month, so as not to annoy the *kLu*[12] deities. Any such contravention could cause the water level to decrease. If the father goes anywhere, he should avoid using the regularly trodden paths and only walk on untrodden ground.

During the period of pollution caused by a death (*Chi-tu*) having occurred in a household, the spouse of the dead person will not leave the house for the next four days. If that person is not living, then the taboo is observed by the next close and responsible relative (*Khor*). The period of pollution after death is known as *Ru-bak* and extends for a month, though in certain cases it may end after four days. The spouse of the deceased will not rejoice nor wear flowers, sing or dance for a year. In case going out is unavoidable then the concerned person will not walk upon trodden paths so as not to afflict the other villagers. The crossing of any stream or the approaching of a fresh water spring is similarly forbidden for fear of angering the *kLu* deities.

If the bereaved household is that of a *La-bdag*, the official with the socio-religious responsibilities of opening a canal during the irrigation period, ploughing the first furrow prior to the beginning of the cultivation season, or of one servicing the village deity, then for the period of one year, these functions will be taken over by the second substituting *La-bdag* from the same *pha-spun*. This is also the case during the birth pollution which extends for a period of one month (i.e. during Bambak). For the four days following death no important work will be undertaken in the village. No canal will be dug or cleaned, nor will fields be sown or harvested. The household will observe mourning for six months during which period no celebrations will be held in their own house, nor will the household members attend functions outside. At the end of this six month period of mourning the Lama will perform the prayer *bSans* (Tibetan: *bsangs*) following which juniper (*Chilgi*) leaves will be burnt and the house cleansed (*Shi-cho*) with the smoke. In Nubra, death pollution (Ladakhi: Zim-ches) is observed for a period of fifteen days to one month (i.e. a girl married out from the household cannot approach the Lha-tho or the Chot-Khang in her natal home) (Vohra 1985).

The same taboos are observed with regard to water, irrigation canals and freshwater springs by the spouse whose first marriage partner dies during Yuk sa or Yuk sa-mo. According to some informants, this is a custom observed by a young spouse bereaved by an early and untimely death. Certain others maintain that age difference plays no role and that Yuk sa is observed by all. This period may be from the beginning of the summer solstice (Ladakhi: Yari Nima), i.e. 21st June to the beginning of the winter solstice (Ladakhi: sGunla Nima), i.e. 22nd December, or vice versa depending upon when the death occurs.

PRESENT DAY AGRICULTURAL ECONOMY

The agricultural economy of the 'Brog-pa is changing very rapidly. Due to the fertility of their land and the enterprising character of the inhabitants, most households are growing crops which are export oriented, bringing them a good income from their sales in Leh and Kargil. In both places a still growing market has developed which has increased its turnover substantially due to tourist influx and the stationing of army personnel. Here remoteness and high transportation costs during a short summer season when passes are open influence market prices for all commodities.

Crops

The first major crop sown is barley (*gono, Hordeum vulgare*) and the second is usually buckwheat (*gum, Fagopyrum tataricum, esculentum*) which requires a shorter period to ripen before winter sets in. The region inhabited by the 'Brog-pa is the only part of Ladakh where two crops are regularly harvested, except for the Chorbat area of Nubra. Other pulse crops grown are *cha-chis-ki* (Urdu: *kangri*), also known as *trumba* and *kangan, ün, kuckyen* (peas, *Pisum sativum*), *nakstran, dag dag chung* (Hindi: *rajma* or red kidney beans), *kirze* (Hindi: *daal*) a type of lentil, and *nagbro* (smaller than *trumba*, but not grown frequently).

A crop of barley or buckwheat at the mDa-'brog pasture area, at an altitude of 3500–4500 metres, is harvested towards the end of summer by those households who have land there. The second crop is harvested along the river Indus towards the beginning of autumn.

Fruit[13]

Fruit production consists of apricots, grapes, apples, peaches, pears, and walnuts. Three varieties of apricots are found: *Phating* considered the best quality, *shikands* (Ladakhi: *halman*) and *chulli*. Apricot kernels from the *phating* variety are like almonds (*ani*; Ladakhi: *giri*), while those from *shikands* and *chulli* variety are pressed for oil (*shono*) which is consumed on festive occasions. The bitter kernels (*tito ani*) are pressed for oil for cooking and use on the hair. The oil cake (*makai*) of the sweet variety of almonds is made into a stew (*khitu*; Ladakhi: *thuk-pa*) adding to it roasted barley flour (*sattu*), salt and water while the bitter almond oil cake is fed to the goats and sheep during winter months. Grapes (*raash*; Ladakhi: *rGun*) besides being eaten fresh are also dried as raisins (*bahsho*) and are eaten in winter. Grape wine is mostly white (Ladakhi: *rGun-chang*) as the red grape variety is grown in smaller quantities. Apples (*pala*; Ladakhi: *kushu*), peaches, pears (*nuti*), mulberry (*shatoot*; Ladakhi: *marunsh*), small berries (*sarchings*) and walnuts (*aatho*; Ladakhi: *starga*) are also grown.

Vegetables

The main vegetables grown are turnips, onions (*chung*), garlic, chillies (*nyerma*) and potatoes. Tomatoes which are a recent introduction (early 1980s) are being produced commercially and grow extremely well. They have begun to augment the incomes of the 'Brog-pa through their sale at Leh and Kargil, alongside the traditional fruit exports. There is also a variety of wild spinach growing in between the fields and along the water canals.

IMPLEMENTATION OF IRRIGATION PROJECTS IN LADAKH

The importance of irrigation for agricultural activity has to be seen as central to any change in Ladakh, be it increasing the availability of arable land, improving existing irrigation facilities or the increasing the yield of the crops. Under these circumstances it is encouraging to see the irrigation projects being implemented by government agencies. For these projects to be durable, however, they must rely upon locally learnt experiences from the past. The area of the Buddhist 'Brog-pa provides an indication of the immense variety of crops, fruits and vegetables which could be grown amidst great hardship of terrain and adverse soil conditions. The irrigation system and the expertise of the 'Brog-pa in manipulating the mountainous terrain in constructing the irrigation canals over generations, can demonstrate ways of exploiting opportunities available to other parts of Ladakh.

The economy of Ladakh was never export oriented, but it was definitely self-sustaining and even prosperous at times, due to the caravan trade with Sinkiang and Tibet. Since the end of this trade, the Ladakhis have been deprived of an important source of economic sustenance. Ladakh has become increasingly dependant on outside goods and supplies. During the year 1985–86, for example, about 6000 metric tons of wheat and rice were brought into Leh district alone. Compare this to the local cereal production of about 7500 metric tons, it shows an almost 50 per cent dependency on outside food supplies. This dependency on imported grain in Ladakh may have its root cause in the breakdown of the social system which was once more interdependent and supportive. In addition there are the effects of the tourist influx.

Household unity and the unity of the land holdings has been maintained for generations in the traditional 'Brog-pa social system (Vohra 1989a: 61–

64). In recent decades this has been increasingly replaced by the founding of neolocal units which often lead to the division of household land into uneconomical small land holdings. These changing marital patterns have also contributed, no doubt, to an increase in population as well (Crook 1980: 139–166). The excess population from the 235 Ladakhi villages has increasingly sought new economic opportunities offered by the various outside groups in the two principal towns; Leh and Kargil. As all available human resources are required for cultivation and harvesting season, even the household members who have taken up outside occupations return to aid their home villages during the sowing and harvesting season.

The dramatic increase in population has increased the human inputs on the socio-economic system. From the table below (Tab. 10.2) one can see that population growth of the last decades has placed a great strain on the agricultural system and the ecological balance.

Tab. 10.2
Population development* in Ladakh 1911–1981

Year	Population	% of growth per decade	average annual growth rate
1911	33 434	2.45%	0.24%
1921	33 873	1.31%	0.12%
1931	35 492	4.78%	0.46%
1941	37 384	5.33%	0.52%
1951	40 487	8.30%	0.80%
1961	43 588	7.66%	0.74%
1971	51 891	19.05%	1.76%
1981	67 733	30.53%	2.70%

Source: compilation based on different population census reports.
*Population figures for Ladakh are separate from those of Kargil area. There are slight differences in the population statistic as provided by Hashmatullah Khan for the years 1911, 1921 and 1931 (Hashmatullah Khan 1939: 478-480). The approximate population statistic for Ladakh for the years 1873, 1891 and 1901 are 20,621, 28,274 and 32,614 respectively (Hashmatullah Khan 1939: 478).

From the Land Records it is evident that despite the villagers' efforts to bring unused land under irrigation, there are considerable portions which remain to be rendered arable if irrigation facilities were to be extended. In 1980 the Desert Development Agency was set up for precisely this purpose. Programmes in soil conservation, stabilization of traditional irrigation system and increasing irrigation potential through minor irrigation works has brought further areas under cultivation. Thus according to one report of the Desert Development Programme, an area of 1365 hectares of land, comprising 12.4 per cent of the net areas sown in the district of Ladakh, was brought under cultivation during the last six years. This, however, included areas rendered barren due to floods and wind erosion. In total 454 tiny irrigation works were erected thus stabilizing facility over 2000 hectares of land and another 1065 hectares of barren land was expected to be irrigated between 1986–88 through four minor irrigation schemes under construction. A further 2500 hectares of land was to be brought under cultivation through the Igo-Phey irrigation project by the beginning of the year 1990 (Chakrabarti 1986: 5).[14]

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NOTES

1. The details of temperature fluctuation are available from the meteorological stations at Leh, Kargil and Dras. Also see 'Records Meterological Observatory', Government of India, New Delhi 1941–1960, where we find Kargil having maximum average temperature of 29.7°C and minimum of 17.7°C while according to the Leh Station a maximum temperature of 24.7°C and a minimum temperature of 10.2°C during the month of July.
2. *'Brog-pa* literally translated would mean a man of the pasture or in Tibet refers to nomads inhabiting the pasture areas. However, here the origin of the designation has a similar meaning but over time has come to imply an ethnic identification for the inhabitants of the villages of mDa, Garkun and Hanu.
3. There are Muslim Dards in Dras, Shina sa Kharbu as well as at Kaksar, sixteen kilometres from Kargil who speak Shina dialects similar to the Dards of Gilgit. Other ethnic Dards who are all Muslims are to be found north of Kashmir in the Tilel and the Gurais valleys (Vohra 1989b) and in the Northern Areas of Pakistan (Jettmar 1975).
4. The custom of shooting an arrow to inaugurate a new place is known from Tibet as well as from the Kalash-Kafirs further west in Chitral. An arrow is shot to establish a village, shrine or the menstruating house (Jettmar 1975: 242–244).
5. A *pha-spun* constitutes a social association of household lineages who are duty bound to help each other through the critical events of life. A Tibetan concept which has been adapted in the different regions, where the Tibetan cultural influence was spread, with its regional variations; for the usage of the *pha-spun* concept among the Buddhist Dards see Vohra 1982: 79–81; 1983: 75–78.
6. Land Settlement Act: "The Records of Rights"—Leh Archives. In the Wazarat of Ladakh, the registration of the land was ordered for the first time through the Land Settlement Act of 1901 (1901 = 1958 *Bikram Samvat* [Bikram Era]; 56 years, 8 months and 18 days need to be subtracted from the Bikram Era to arrive at the date of the Christian Era, i.e., the Gregorian calendar/chronology). The Land Settlement records were conducted under the supervision of R.T. Clarke who was the then Settlement Officer of Baltistan and implemented these under the order of the Council's resolution. However for mDa area it was completed in 1908 under the Collector Settlement Chaudhri Kushi Muhammad. Here are enumerated the characteristics and details as compiled at

that time. The village of mDa, for example, was covered under the area Skurbuchan and held the boundary demarcation No. 68 in the Tehsil of Ladakh. Thus it is in the register No. 68 that the details of the land records, livestock, trees, water mills, irrigation sources and canalization, etc. are recorded. This register contains a detailed map of the village with the fields numbered according to household ownership and the demarcation of their irrigation sources. In the index of the register one finds the contents enumerated and the total amount of cultivated land mentioned as well as the genealogical table of the households of the village (details see Vohra 1989a: 85–138) with records of the transfer of land to the succeeding generations. Here we also find the village customs regarding irrigation, use of the water mill, repair work of the canals and fields, grazing rights and death customs. Other data mentioned in the Records of Rights are six water mills in mDa. The mills are used through nine months of the year and each has the capacity of grinding thirty-six *seers* of grain in twenty-four hours. The villagers are recorded to own five ploughs. The ploughs and the axes of the villagers are repaired by craftsmen from Skurbuchan. The craftsmen come regularly to do the repair job but can also be summoned in an emergency. The payment is made at the time of sowing and harvesting of the crop. Each household gives between eight to fifteen cups of grain on both these occasions and this is in accordance with the amount of land owned by the household. Repair work in the household and other carpentry jobs are executed by workers from Kargil. Ladakh received tribute from the various regions in the form of the products each region produced. Tribute was paid to the rulers of Ladakh in the following manner:

In mDA the land was owned by 43 households of which two were Muslim households from Sanjak village. The total land owned was 1339 kanals (8 *kanals* = 1 acre) of which the cultivated portion was 1027 *kanals*. The land holdings were increased during the following years as is witnessed by the Record of Rights of the Bikram Era years 1908, 1918 and later in 1925 conducted under the supervision of Chaudhri Kushi Muhammad. Here it is demonstrated with the aid of a map that land belonging to the government was being successively taken over and brought under cultivation by the villagers. According to the Record of Rights registers, for the year 1925 of Bikram Era, the total land holding of the villagers amounted to 1563 *kanals* and 3 *murla*. The total land revenue paid amounted to Rs 400/- and a further Rs 50/- for their livestock. The land revenue could be paid in four installments and was collected by the village functionaries responsible to the government, i.e., the *Numbardar* and *Kotwal*, who were exempt from the revenue. The village headman, or *Numbardar*, was entitled to keep 5 per cent of the land revenue as his commission. Land revenue was divided into three classes and each class was according to the amount of overall income.The land revenue could be paid in currency or in the local commodity. The two commodities accepted in payment were wood and grain. The approximate conversion rate was two *maunds* of wood or sixteen *seers* of grain (one *maund* = forty *seers*, one *seer* = two pounds) equaling one Rupee. In case the revenue payment was made in the form of wood then it had to be transported to Leh while payments in grain had to be deposited at the granaries of Saspol or Lamayuru.

7. The land revenue system of Ladakh, during the rule of the rGyal-po of Ladakh who ruled until the early nineteenth century, was not applicable to the Buddhist 'Brog-pa villages which maintained an independant status as petty chiefs between the kingdom of Ladakh and the rulers of Baltistan (Vohra 1989: 12–18). Until the Dogra invasion the rulers of Ladakh received tribute from the various regions in the form of products each region produced. Tribute was payed to the rulers of Ladakh in the following manner: barley was provided for the royal household from twenty-four villages in Nubra for six months of the year and for the other six months the villages of Lamayuru, Skurbuchan, Tinmosgan, Saspol, Basgo, She and Tangtse. Meat was provided by Tangtse and Rupsho.

Butter was mainly supplied by the villages of Zanskar though small amounts of it was also supplied by Tangtse and Rupsho. Wood was mainly provided by Sumda and Dhumkhar (Hashmatullah Khan 1939: 427; different figures provided by Petech 1977: 159–160). *Pattu*, or woollen cloth, was provided by every household manufactured from three quarters of a *seer* of wool, however it was mostly the people of Tangtse who provided *pattu* (Hashmatullah Khan 1939: 427). Cunningham (1854: 267–270) mentions a house-tax collected amounting to Rs. 30,000 during the last years of the Ladakhi kings independance. Taxes on households (house; Tibetan: *t'ab-k`a* = firehead) was collected in the main crop, i.e. barley (Tibetan: *'bru-k`ral*). However the poorer households were exempt from the house-tax but provided labour service (*'u-lag*) and these formed the majority of the households (Petech 1977: 158–159). Every year the sheep and goats owned by each household were counted and for every ten animals they were to give one to the king to be herded by the royal shepherds. Petech (1977: 158) mentions a 10 per cent tax on cattle (*bcu-k'ag*).

8. During the early rule of Zorawar Singh (first invasion in 1834) no administration was introduced in Ladakh and he received at first Rs. 9000 as tribute which sum was subsequently doubled (according to Petech Rs. 20,000 and later in 1838 Rs. 30,000; Petech 1977: 140–143). However after the third invasion of the Dogras and under *thanadar* Magna Ram and *wazir* Ratanu the amount of tax was fixed according to each landowner's property who were divided into three classes for this purpose (Hashmatullah Khan 1939: 429). Under *wazir* Basti Ram taxation was extended to the shepherds who were to pay one seer of butter, one seer of wool and some woollen cloth per goat. Though, under Magna Ram, Skurbachan was made to pay more tax due to its system of double cropping (Hashmatullah Khan 1939: 429) it is not certain whether the isolated 'Brog-pa villages, further down the Indus, were included.
9. The Record of Rights also provides a count of the animals in the village. A tax of Rs. 50/- is paid by the mDa villagers for the animals. The records provide detail of 4 horses, 13 donkeys, 10 bulls, 158 sheep and 304 goats which are allowed to graze on government land for the tax paid. Once the crops have been harvested the villagers let their livestock graze in their fields. Once threshing is over the grazing in the fields is permitted without restriction as to the ownership of the fields.
10. Deity of Ice, the source of water; Ladakhi: *gangs* = Ice.
11. Leh Archives along with the Leh prison were located in 1978 at the centre of Leh bazar where I worked for several days. I believe that in the meanwhile the archive records have been moved to separate quarters near the Deputy Commissioner's office.
12. *kLu* are the deities of the soil and underworld who are thought to be living in water sources and springs and protect them against pollution.
13. The Record of Rights also provides the number of fruit trees in the village. Thus we find the existence of 99 walnut trees, 2423 apricot trees, 159 apple trees, 24 pear trees and 53 grape vines.
14. Mr Prabodh Dhar Chakrabarti was the then Additional Development Commissioner and the Chief Project Officer in Leh, Ladakh who kindly provided the information on the irrigation projects in 1986.

11

Traditional Oases of Ladakh: A Case Study of Equity in Water Management

Valerie Labbal

Ladakh is a remote region of India, within the Jammu and Kashmir State (Fig. 11.1). Inhabited mainly by a population of Tibetan culture (the region was known as "Little Tibet" by travellers), Ladakh used to be an independent kingdom until the nineteenth century. It was annexed by the Maharajah of Jammu in 1846, then united with India in 1947. At the present time, Ladakh is divided into two districts. Our study[1] takes place in Leh District, Leh being the capital of the former kingdom.

LADAKH, A DESERT REGION IN THE HIMALAYAS

Ladakh is a high altitude area in Leh District, with land elevations ranging from 2990 to more than 6000 metres. It lies behind the Great Himalayan range, at the western end of the Tibetan plateau, creating an arid continental climate.

The mean annual precipitation is very scanty: usually varying from 80 to 100 millimetres per year.[2] Precipitation occurs in the form of winter snowfall from December to March and irregular rainfall during the other months, especially in July and August. As precipitation increases with altitude, winter snow cover is heavier on mountaintops than on valley bottoms. Summer rainfall results from the monsoon and is very low since monsoon clouds are nearly exhausted by the time they reach this remote region. Due to very low atmospheric humidity and reduced atmospheric pressure at these high altitudes, solar radiation is intense. Temperature ranges are great. Mean monthly temperatures usually vary from –14°C in January to 25°C in July. Above all, temperatures are very low throughout a great part of the year.

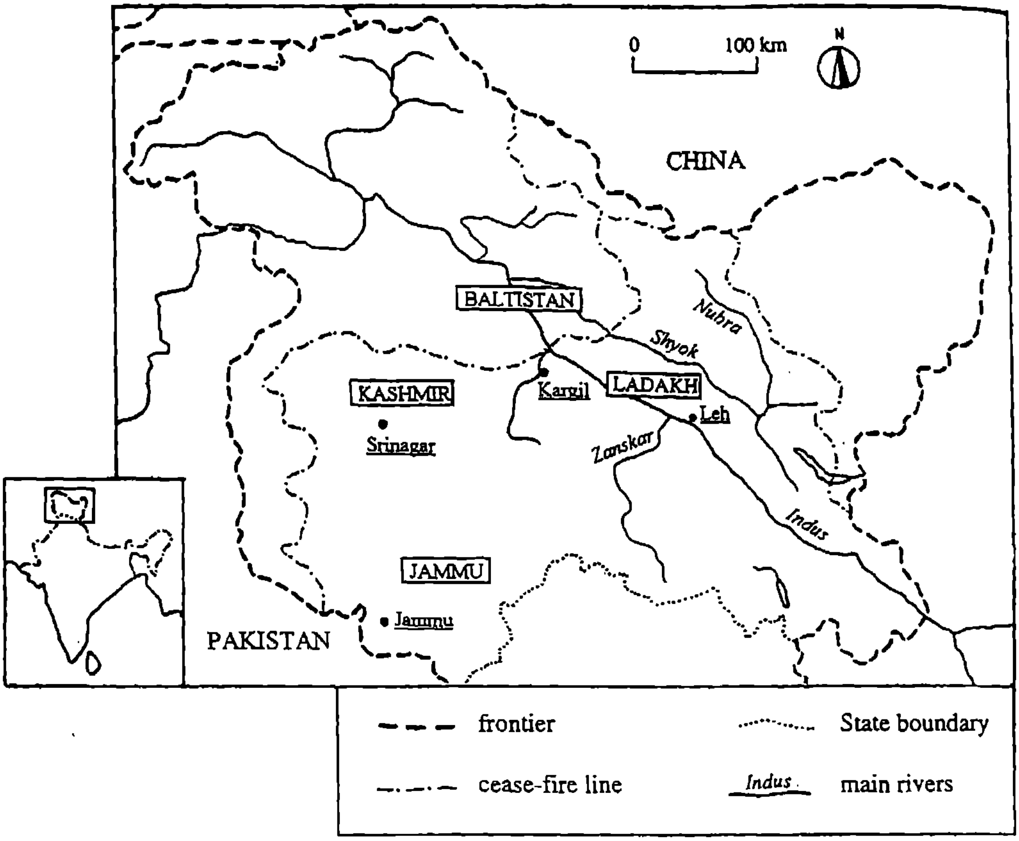


Figure 11.1: Map of Jammu and Kashmir.

These climatic characteristics create strong agricultural constraints. Low temperatures restrict the growing season from May to September. Intense solar radiation produces high evapo-transpiration. Precipitation is therefore far from meeting vegetation requirements and rain-fed agriculture is impossible. Only irrigable areas can be cultivated.

In the district of Leh, two major sources of water are available for irrigation: the Indus River and snow-fed streams. The Indus Valley appears as a wide and elevated plain from the village of Martselang (3380 metres) to Spituk (3200 metres). It lies between the Ladakh range (culminating at 6213 metres) and the Zanskar range (7156 metres). Between the spurs of both ranges, narrow lateral valleys are drained by streams. Hence, human settlements are confined in small discontinuous oases scattered within a barren environment. They are located along watercourses either in the Indus valley or in lateral valleys. The two types of oases that we mentioned correspond with two kinds of irrigation systems.

Oases of Ladakh

The Indus River is the water source of the alluvial plain. The oases located in the plain are known by the local population as *rgya-shod*, "low and wide places". The Indus flow fluctuates monthly and annually.[3] High flows occur in summer due to increased snowmelt. Water is plentiful, however, when compared to irrigation requirements of the oases. Unfortunately, the Indus Valley is also the setting of destructive floods reported by travellers,[4] that swept away houses and fields.

Their irrigation network (Fig. 11.2) is constructed as follows. A long stone diversion structure, almost parallel to the river banks, diverts part of the river water. Then, a main canal leads to a flat, cultivated area which generally lies several kilometres away. The diverted flow is sufficient to simultaneously fill numerous secondary canals for the entire growing season. Under such circumstances no rotational system nor water regulation are required.

On both sides of the Indus valley, small snow-fed streams irrigate oases at higher altitudes. These oases are called *phu-lhags*, "high and cold places". As with the Indus, these mountain streams show seasonal flow variation.[5] In winter, the streams are usually frozen along their course, but the agricultural

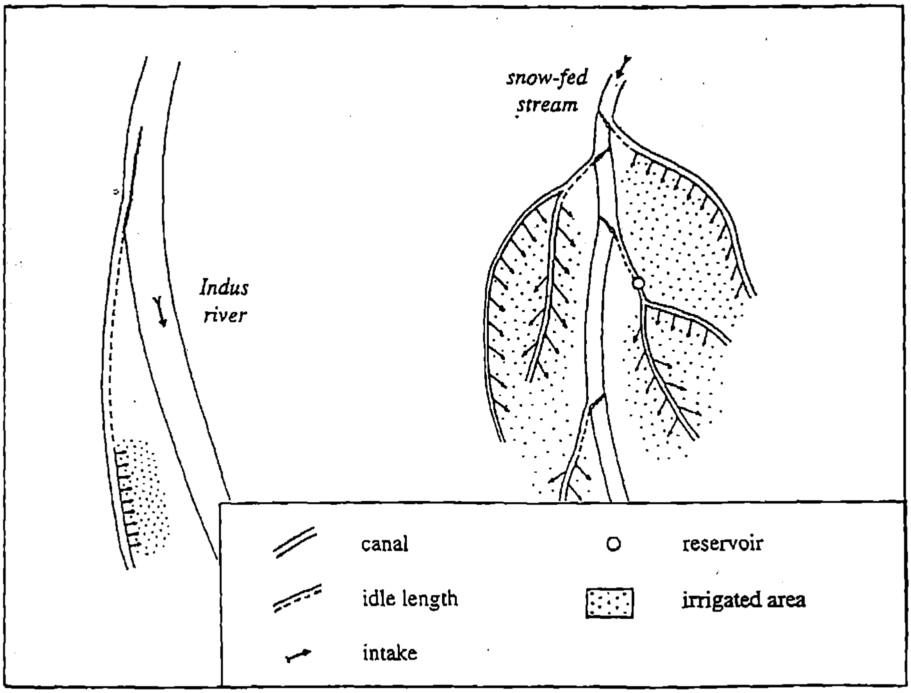


Figure 11.2: The two types of irrigation systems in Ladakh.

season is over by that time. Spring, however, is also a period of relative water shortage. It is characterized by daily variations of flow, due to the delay between the snow melting in the mountaintops and the arrival of snow-melt water at the oases. This means that the maximum flow is available for irrigation in the evening. There is more substantial melting of snow when temperatures rise during the summer. This causes the first massive floods drained by the streams which are called locally *chu-phel*, "increase in water". Water carries a heavy sediment load during *chu-phel* days. Afterwards, the flow remains at its highest level until the return of cold days.

Areas irrigated by mountain streams are located on fluvial deposits in the valleys or on alluvial fans. Deposits have a slight slope; consequently fields of this type of oasis rise in terraces. Water is diverted by numerous intake dams within an oasis (Fig. 11.2).

In the spring, before the arrival of the floods, streams do not supply enough water to simultaneously fill several canals. They do not even supply enough water to irrigate all the plots served by a canal. Water allocation is necessary and is then governed by a rotational system. This regulation of water use is organized by the community. The Sabu oasis, located six kilometres east of Leh, provides a good example of how such irrigation practice is carried out.

FARMING PRACTICES IN SABU

Sabu is said by local people to be a fertile oasis. About 130 hectares are cultivated in a long south-facing valley where terraced fields rise from 3350 to 3950 metres in altitude.

In fact, the valley shelters two sub-oases which are separated by a narrow strip of barren land. The main oasis located upstream is the subject of our study. The smaller one downstream is a more recent settlement which is not involved in the water management of Sabu.

The Unit of Production: The *grong-ba*

Sabu comprises 119 households or *grong-ba*, most of them belonging to the Buddhist religion. Only seventeen Muslim and two Christian households are reported. The *grong-ba* is the social unit of the community.[6] The social position of every individual is defined by his being part of a house and he is then identified by the name of the house to which he belongs. Households have rights and duties within the community and any of its members can represent it or fulfil the obligations assigned to it. A headman deals with the community affairs. He is selected at a meeting of representatives of each household.

During the king of Ladakh's rule, some households were responsible for carrying out specific duties, which remained the same from generation to generation. Even today, the names of these households reveal their former duty; for example: *mkhar-dpon,* "responsible for the fort", or *chu-dpon,* "responsible for irrigation". These differences in responsibilities have produced differences in social status.

The traditional system of land inheritance aims at keeping the holdings undivided. This includes buildings, land, livestock, and tools; all of which taken together are assumed to form the "household". Usually, the eldest son inherits the property, but the eldest daughter may be eligible to inherit, especially if she has no brother, if the son is too young at the time of inheritance or if the son is destined to enter the monastery.

Traditionally, parents of the heir and their other children move to a "small house", which becomes an offshoot of the main one. They are then given usufructory rights over a part of the household's land. Nowadays, more and more of the younger children settle in this way and obtain a few plots of their own from the main household. The household is also the unit of production. Its cultivated land ranges from two to eighty *kanals,*[7] according to the origin and development of each household. The status of the household determines the difference.

Nowadays, agriculture is not the only activity in the area. The proximity of the town of Leh offers many job opportunities, and in Sabu at least one household member contributes revenue from non-agrarian activities.

Crops and Livestock

Only single cropping is possible in Sabu, with barley, wheat, peas and mustard being cultivated. The main crop is barley as the Ladakhi staple food consists of roasted barley flour. The area sown with wheat is limited and it is not grown above 3600 metres. Nowadays, areas sown with peas and mustard are of minor importance. Potatoes, on the other hand, introduced about a century ago, are cultivated as a cash crop in Sabu, mostly for sale to the army. Vegetable gardens and fruit trees (apples and apricots) are confined to lower altitudes. They occupy a confined space in the vicinity of the houses. Willow and poplar plantations provide wood for tools and roofing material. Perennial lucerne (*alfalfa, Medicago sativa*) plantations, bordering the oasis, are grown for winter fodder and are supplemented with the straw of any crop.

Nearly every household owns a few cows and *mdzo-mo*, the female crossbreed of yak and local cow, in order to provide dairy products essential for Ladakhi tea (a salted tea with butter). The male *mdzo* is the draught animal of the region. Only one male yak is kept collectively by the villagers of Sabu, for crossbreeding purposes. Donkeys are the common pack animals. Goats and sheep, nowadays, are kept only by a few households.

Irrigation Pattern

All crops are under irrigation. Before sowing, fields receive an initial watering: *tha-chus*, also named *skya-chu*, "water for the bare soil" or "water for the grey soil". This practice aims at preparing the soil for the operations to come. Thus, at the time of sowing, when villagers meet some tillers, they greet them with *gsher lags-mo le*, "Wish you a proper moisture!" Sometimes, *skya-chu* is not necessary when soil is already sufficiently moistened due to a late snowfall. The two practices[8] may simultaneously coexist in the same cultivated area, and the option of which to select is left to each landholder. The fields are then identified as: *chu-gsher*, "moistened by water", and *kha-gsher*, "moistened by snow". The *kha-gsher* practice allows planting to begin earlier; there is no need to wait for one's turn to utilize water.

Rdol-chu "water at the germination" is the first irrigation of the growing season. The second one is called *sreg-chu* or "water at the burning point". The meanings of the irrigations which follow are less obvious. The third one is called *gnon-chu*. After *gnon-chu*, several unspecified irrigations are carried out with a greater frequency (every seven days for high quality barley fields) depending on the composition of the soil and the variety of the crop. The final irrigation, called *dro-chu,* is applied with the intent of softening the soil to make harvesting easier, enabling farmers to pull stalks out completely and get as much straw as possible for fodder.

Co-operation and Community Management of the Cultivated Area

Households engage in mutual aid for agricultural labour. Several households (usually two) may share farm tools, draught animals and labour. At the beginning of the season, all the households collectively use their donkeys for the transport of manure to the fields. Farming activities are also a community affair. The cultivated area is managed in a collective manner so as to maximize co-ordination between agricultural and husbandry practices. The harvest date of lucerne and wheat, for example, is restricted for all the villagers to a few days each year. The harvest period is declared, either by the head of the village and his assistants, or during a village meeting called *'du-sa* in which one member of each *grong-ba* takes part. After the harvest, animals are free to graze on stubble in newly cropped areas: first, in lucerne plantations, and in the rest of the oasis once the wheat is harvested. Every year, by turn involving all the houses, two *lo-ra-pa* or "guardians of the harvest" are appointed to prevent any damage to crops by stray animals.

Agricultural operations and rituals are intimately connected throughout the year. Rituals are scheduled by the astrologer and performed by the Buddhist monks of the village. The rituals are aimed at obtaining a good harvest or at pleasing the spirits of the underworld disturbed by the agricultural labour. Few rituals are offered individually on behalf of one household. Most of them are performed for the benefit of the whole community.

THE IRRIGATION SYSTEM OF SABU

The irrigation system of Sabu is a gravity-fed system. An irrigation network comprises a set of structures ensuring water diversion, conveyance and storage. In Sabu, they are very simple structures which are maintained by the farming community.

Water Diversion Structures

The structure of the diversion dams is very simple. A few large stones obstruct the entire width of the riverbed. Stones, gravel and rags are added to avoid leakage. When one canal or another is not required, stones are removed from the diversion dam and are used to close the head of the canal through a similar stone structure. The diversion dam's vernacular name is *chu-bkag,* which literally means "closure of water". Within the oasis, there are many intake dams along the stream. The irrigation network therefore has a ramified layout.

The Water Conveyance System

Water is conveyed through earthen canals, *yur-ba,* which are not usually well dug. Their bed is shallow and filled with stones, gravel and sand. The canals whose intakes are located in the centre of the oasis have a short idle length. Their course is irregular and may even follow the steeper slope. Some canals look like gullies running between terraces and are used as walkways. Others meander within grasslands.

The irrigation network reveals an intricate pattern of canals which cannot be easily formed into a hierarchy of primary, secondary and tertiary units

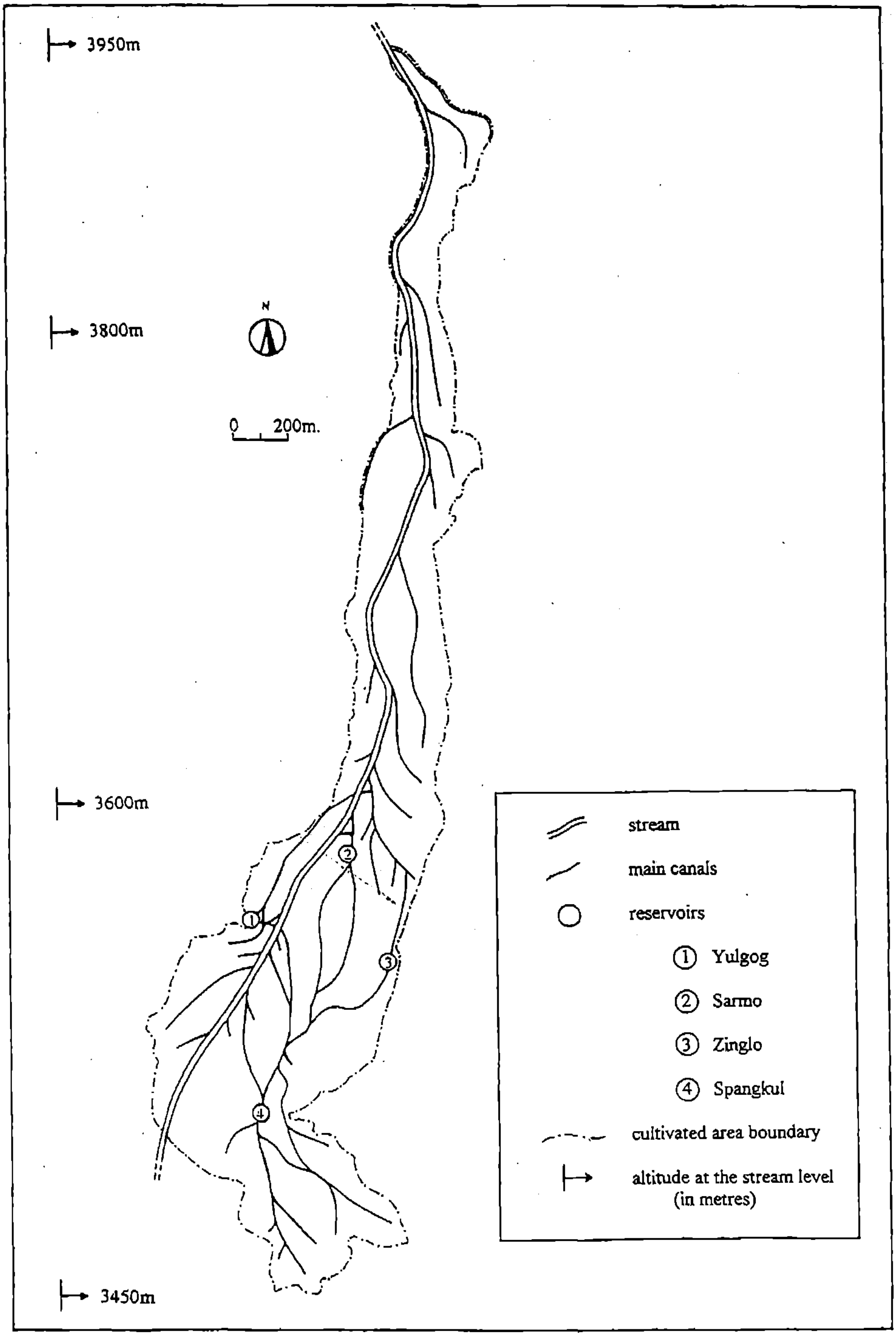


Figure 11.3: The irrigation network of Sabu village layout of the main canals

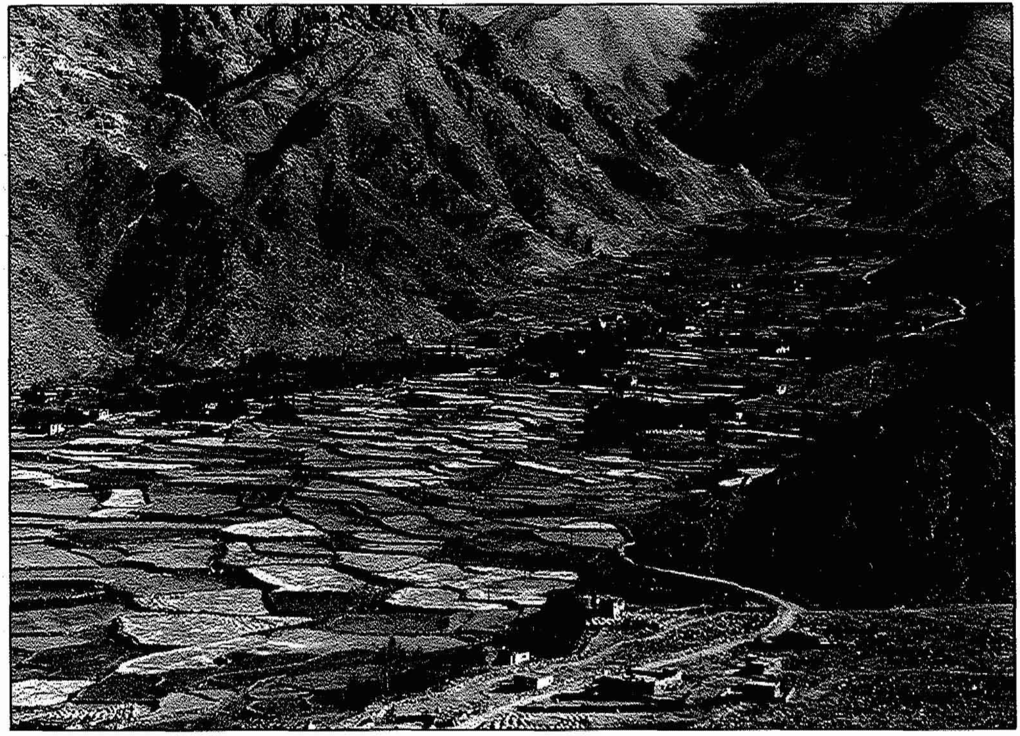


Photo 11.1: The upper part of the valley of Sabu (Valerie Labbal).

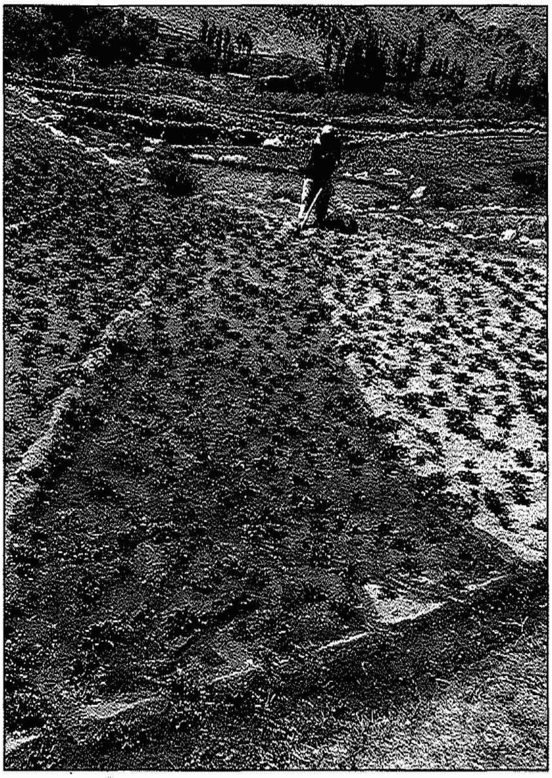


Photo 11.2: Irrigation of one area between borders (Valerie Labbal).

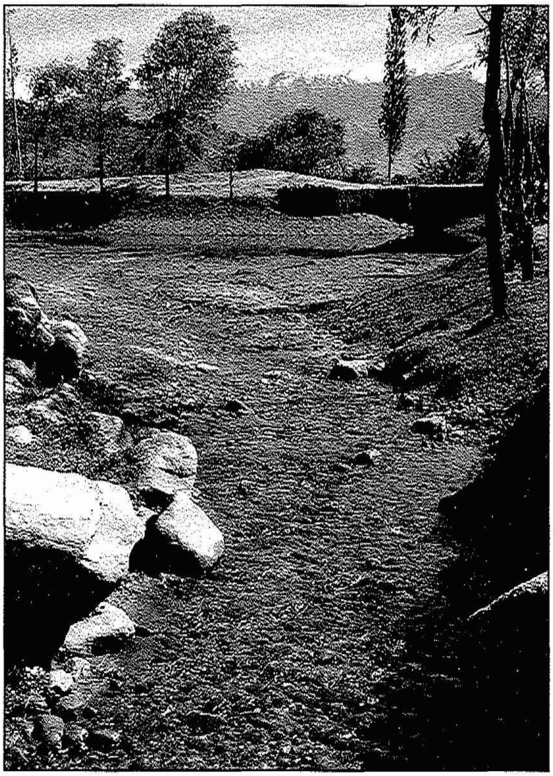


Photo 11.3: One of the main canals (Valerie Labbal).

(Fig. 11.3). Nevertheless, each main canal has its own name, which is also used for the irrigated area it supplies.

After being diverted, water is directed through this complex network through a series of small diversion structures *rka*, which function as sluice gates at each intersection. The structures are made of few large stones frequently placed on a bed of sod. Sand, gravel and sometimes rags are added.

Water Storage Structures

Four reservoirs or *rdzing* have been built in the Sabu oasis. Earthen embankments, planted with willows, dam the sites. The middle part of the embankment is reinforced with stones and cement. Three of the reservoirs are operated in the same way. Their dams have two water outlets (Fig. 11.4). The first one, called *chu-mchar* or "waterfall", is a simple horizontal aperture at the upper part of the dam. Continually open, it is used for draining overflow. The second one, called *hor-mi-lig* or "whirling eye", is the bottom aperture system used to empty the reservoir when irrigation is required. It is comprised of from one to three cylindrical and vertical apertures which lead to a horizontal conduit that opens outside.

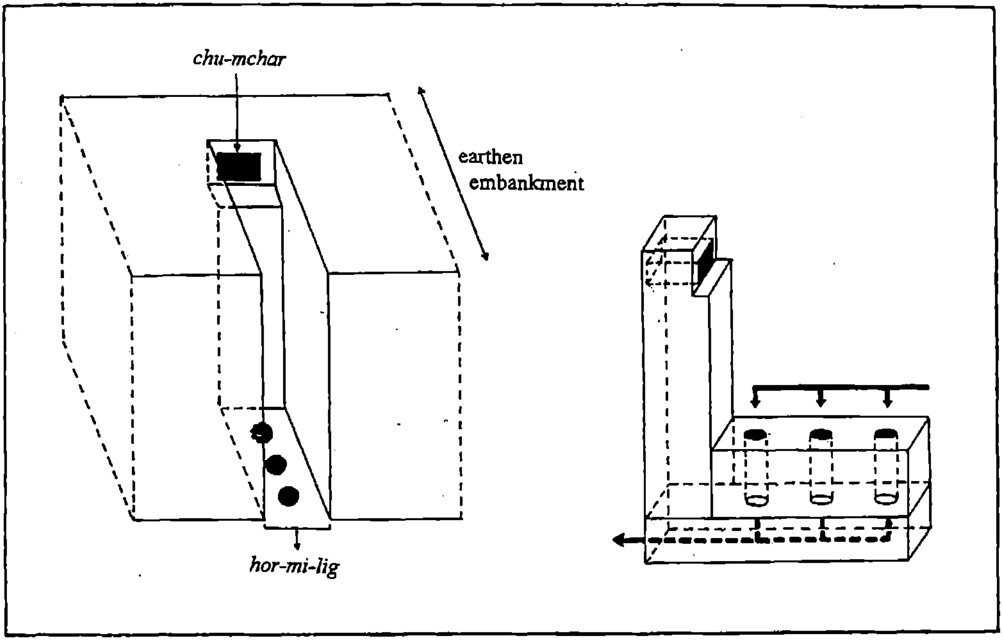


Figure 11.4: Apertures of the reservoirs

Reservoirs are filled by plugging the cylindrical apertures with a piece of turf. Because of the nature of this plug, the diameter of the aperture cannot be wide. Consequently, a high flow of released water is obtained by opening several outlets. In order to empty a reservoir, water users handle a long wooden pole. They use it to push the pieces of turf out through the horizontal conduit.

Reservoir management functions in the following manner throughout the year. During the growing season, reservoirs are filled at night in order to release water for irrigation in the daytime. Towards the end of the growing season, all have been opened, so the water will not freeze quickly if temperatures decrease suddenly.

Each reservoir has a name known to all the villagers. Yulgog reservoir (Fig. 11.3) is located at the site of the valley's historic village and fort. Two meanings are suggested by the villagers for its name: either *yur-gog* "ruined canal", or *yul-gog* "ruined village". Sarmo reservoir, the "new one", has the greatest storage capacity. It supplies the largest cultivated area in the heart of the oasis. It can have a high discharge as three apertures are opened for its *hor-mi-lig*. Spangkul reservoir serves the lowest lying area. Its name corresponds with its location "at the lower corner of the grassy land". Zinglo is the smallest reservoir. It seems to be older than the others, according to local tradition, and therefore it demonstrates the original historical structure of this type of reservoir, with only one water outlet consisting of a horizontal aperture at the base of the dam. The toponym is derived from *rdzing*.

System Maintenance

The annual cleaning of the irrigation network is collectively performed on the proper day chosen by the astrologer in March of the Gregorian calendar. One member of each *grong-ba* is required to participate. Work is supervised by the village headman and three villagers in charge of water management for the season, the *chu-dpon*. All four assign the work while a villager reads prayers intended to please the spirits and deities. Young people dig out big pieces of turf that the women carry up to the intake dams and reservoirs. Men check the reservoir dam and repair it if necessary. Everyone then participates in removing the sediment from the reservoirs, spending an entire day at each reservoir (except for Zinglo). The *chu-dpon* imposes fines on every "absent" *grong-ba*.

FIELD APPLICATION SYSTEM

In Ladakh, border irrigation is the method for applying irrigation water to fields. Fields to be irrigated are divided into parcels called *shag-gu* (Fig. 11.5), bounded by parallel earth ridges or bunds nearly ten centimetres high. During irrigation, water channelled by bunds moves down the border slope, infiltrating as it goes.

The Border System or *shag-ris*

Borders are generally rectangular in shape, except along field edges. Border width varies from one to two metres for cereal plots. Their length may reach five to ten metres. In the same plots, it is therefore common to see several lines of borders,[9] called *nangs,* separated by field channels or *nang ri-mo.* The system of bunds which encloses the borders is called *shag-ris.* They are built up at the beginning of the growing season, after sowing. At

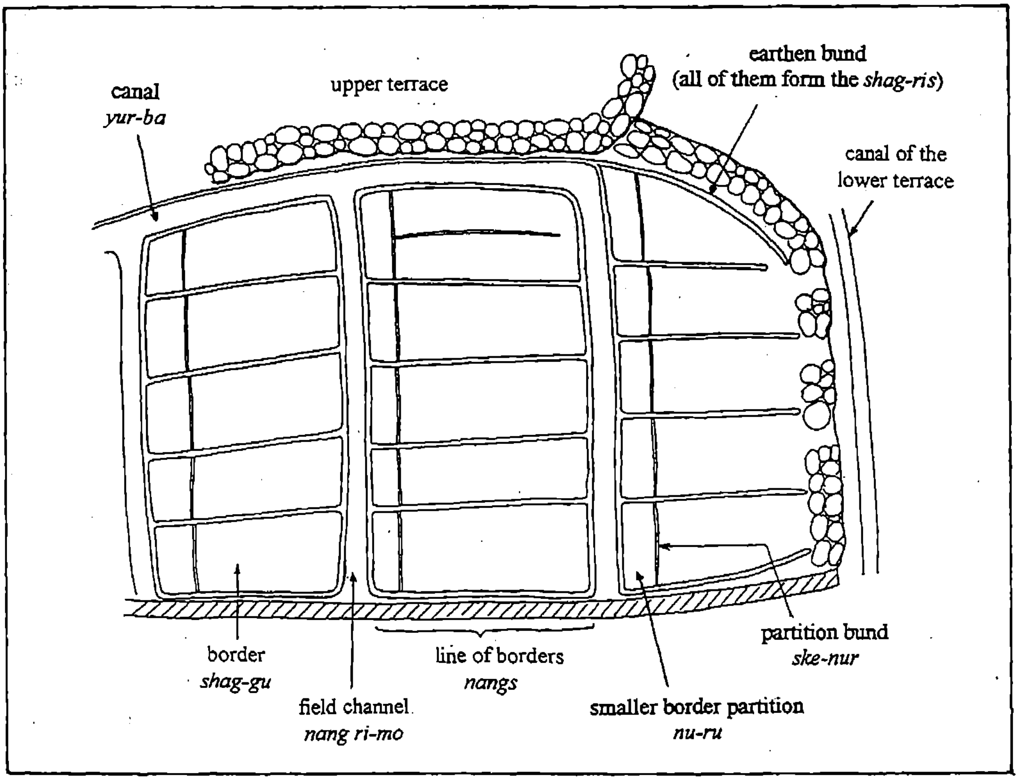


Figure 11.5: The system of field borders, *shag-ris.*

the same time, border surfaces are levelled. In order to spread water with uniformity, borders must have a gently lengthwise slope as regular as possible, and a nearly zero-degree widthwise slope. Each border is divided cross-wise into two unequal parts, separated by an inner bund. The smaller partition lies at the upper part of the border. It is termed *nu-ru* by the water users and the partition bund is called *ske-nur* or "neck of the *nu-ru*".

Irrigation Practices

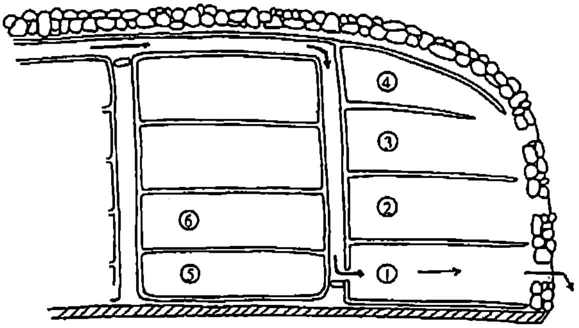
In each field, the first irrigation of the growing season begins by the border which is located the furthest afar from the field's water entering point (Fig. 11.6). The water user digs an inlet into the upper bund of the border with his shovel. One shovel full of earth is laid into the field channel in order to divert the water towards the border. Water flows through the opening into the first partition. Once this partition is flooded, many cuts are made with the shovel through the inner bund. Such a method permits a more uniform spreading of water in the main partition. Then the sheet of flowing water moves down the slope of the border, guided by the border bunds. At the lower extremity of the border, the excess flow is drained off through an outlet. It flows down to the field channel of the lower terrace. Water users determine whether the soil moisture is sufficient by testing soil consistency with a shovel. The same method is repeated for each remaining border.

Because of the unlevelled surface, water users have to readjust the area of the borders during the first irrigation (*rdol-chu*). At that time, two or three workers are required. By adding earth or digging little furrows, they achieve a uniform spreading of water. After this first irrigation, *rka* are not removed. As a consequence, the second irrigation of the season (*sreg-chu*) begins at the border located the closest to the water-entering point.

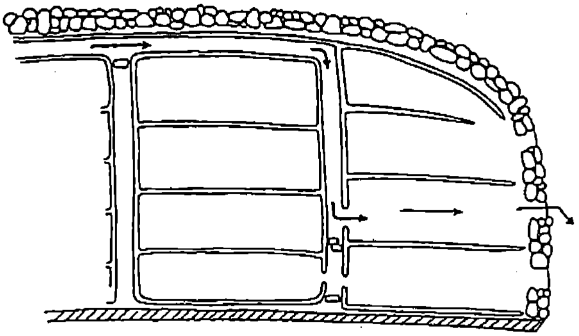
At the field level, run-off and seepage processes are equally prominent. As can be observed, water runs continuously down the slope of the borders and drainage water is plentiful. For this reason, this technique has a very low Field Application Efficiency; that is to say the ratio of the amount of water actually allocated to the crop and the amount of water supplied to the field is low. This is a technique suitable for situations where water is relatively plentiful.

SOCIAL MANAGEMENT OF THE IRRIGATION SYSTEM OF SABU

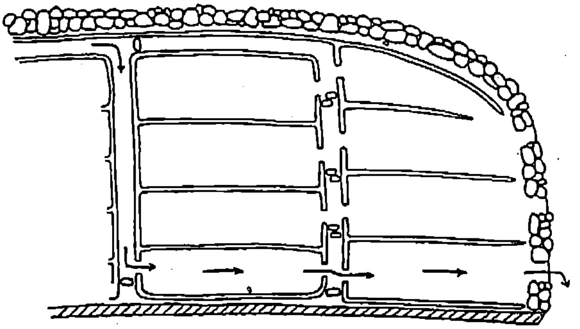
Diversion, conveyance, storage and allocation of water are not only technical activities but also social ones. They are bound to be directed according to



1st stage : flooding of the first border



2nd stage : flooding of the second border



5th stage : flooding of the fifth border

Figure 11.6: Water application to a field with several lines of borders

power relationships and cultural values prevalent in the society where they occur. Hence, the study of an irrigation system must also include its social management, i.e., the written or unwritten agreements which govern water management and especially water allocation.

In Sabu, water management comprises two phases. Transition from one phase to another depends on the spring floods, *chu-phel.* They occur at a variable time (end of June 1993) according to seasonal thermic conditions. We shall distinguish water distribution before and after the flood. The water distribution during these two periods is governed by common agreement.

Water Distribution Schedule Before the Floods

Before the commencement of the flood, there is a period of water shortage. Thus several fields cannot be irrigated at the same time. For that reason, water must be apportioned according to a turn system: *chu-tshir.* Two rotational systems are implemented: one for water distribution among the reservoirs and canals, and one for water allocation to fields along each canal. During this critical period, three villagers are in charge of the whole irrigation system.

Rotational Distribution Among Reservoirs and Canals

Filling of the reservoirs takes place at night. When rotation is first initiated in a given year, the entire night flow of the stream is diverted and conveyed to Yulgog reservoir every night. Its filling requires several hours. As soon as Yulgog reservoir is full, one *chu-dpon* directs the flow to Sarmo reservoir for the rest of the night. On the following morning, both reservoirs are opened and the released flow is diverted to the uppermost canals. It takes a few days to complete the irrigation of all the fields, depending on each canal. When irrigation is completed for one canal, water is allocated in turn to the rest of the canals, usually from the top down. In the case of Yulgog, water has to cross or follow the streambed every time a canal located on the opposite bank is required to be filled.

When water allotment for the fields dependent on Yulgog is completed, the night flow of the stream is directed to Spangkul reservoir and the irrigation of the lowest area begins. In the same way, once half of the fields dependent on Sarmo are irrigated, stream flow is shared between Sarmo and Zinglo reservoirs during the second part of the night. In each turn, the day flow is directed to the canals whose intakes are located above those of the reservoirs.

Rotational Allocation to Fields

For a canal, community rules stipulate that water allocation to fields follows a sequence based on the location of the fields, or more precisely of the sluices along the canal. The order is established from the upper sluice *rka-mgo*, "head sluice", to the lower sluice *rka-mjug*, "tail sluice". Water allocation is not governed by time and volume. The beneficiary diverts as much water as he needs from the canal. His entitlement is finished when soil humidity is regarded as sufficient. The duration of allocation is therefore largely determined by the water supply making it impossible to schedule distribution according to time. Consequently, problems of organization within the household may occur at the times of *skya-chu* and *rdol-chu* irrigations which require several workers. Manpower may not be available when water is finally allocated to the respective households.

As we can see from the two rotational systems, when there is water scarcity, water released during daytime is directed to no more than three fields at the same time.

Crop Irrigation by Turns

A complete turn for water allocation in the oasis concerns only a few crops and of course one type of irrigation (Fig. 11.7). Wheat and barley, the two main crops for example are not watered during the same turn, because their growing cycles have different durations. For this reason, the first turn of the irrigation cycle is performed in order to allocate *tha-chus* to the fields which will be sown with wheat, potatoes, peas or mustard (in 1993, this turn lasted twenty days). Once the first turn is over, lucerne and tree plantations are watered. The second turn concerns *tha-chus* for the fields which will be sown with barley (in 1993, this turn lasted thirty days because, in total, the areas to be sown with barley were larger than the others). After every turn, water is diverted again to lucerne and tree plantations. This regulation continues until the end of the water scarcity period. Potatoes, recently introduced in Sabu, have been integrated into water turns for wheat, peas and mustard. It can be noted, as well, that the field application of water for potatoes is performed with techniques identical to those used for traditional crops.

Vegetable gardens, on the other hand, depend on specific irrigation schedules. Their water requirements are very different from those of other crops. For that reason, villagers apply another irrigation technique, basin irrigation, to their raising. Basin irrigation consists of flooding small basins enclosed by low bunds and hence there is no drained water. Before diverting part of the flow of any canal to their vegetable gardens, villagers ask the

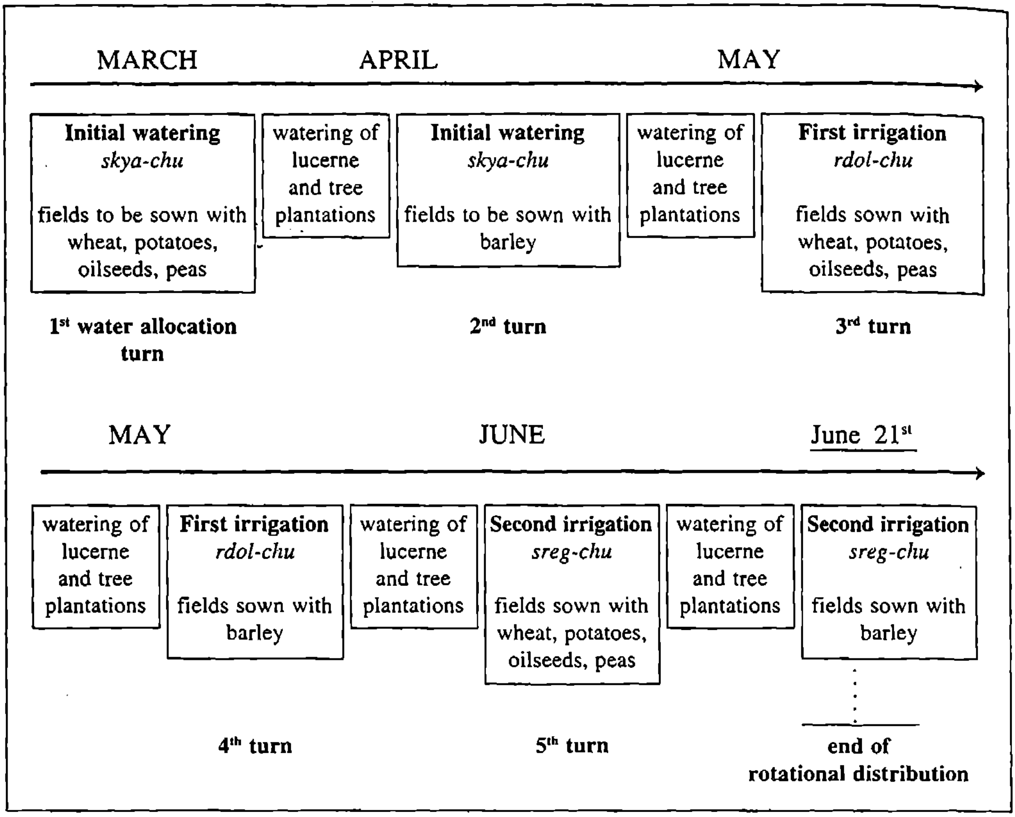

MARCH
APRIL
MAY
Initial watering
skya-chu
fields to be sown with wheat, potatoes, oilseeds, peas
watering of lucerne and tree plantations
Initial watering
skya-chu
fields to be sown with barley
watering of lucerne and tree plantations
First irrigation
rdol-chu
fields sown with wheat, potatoes, oilseeds, peas
1st water allocation turn
2nd turn
3rd turn
MAY
JUNE
June 21st
watering of lucerne and tree plantations
First irrigation
rdol-chu
fields sown with barley
watering of lucerne and tree plantations
Second irrigation
sreg-chu
fields sown with wheat, potatoes, oilseeds, peas
watering of lucerne and tree plantations
Second irrigation
sreg-chu
fields sown with barley
4th turn
5th turn
end of rotational distribution

Fig. 11.7: Irrigation schedules during water scarcity period.

chu-dpon for permission. They are considered water thieves if they fail to do so.

The Functions of the *chu-dpon*

Three *chu-dpon* are appointed during a village meeting that follows the annual ritual of *sa-kha phye*, "the opening of the mouth of the Earth". This ritual is performed in the early spring and marks the beginning of farming activities in a symbolic way. Then, two village *grong-ba* are nominated according to a turn which affects all the *grong-ba* holding land. The basis of the list is the supposition that all the houses of Sabu are located around an accepted clockwise circle.[10] Each of both appointed *grong-ba* has to provide one male household member for this duty. The third *chu-dpon* is selected because of his practical knowledge of the network. Usually, this position is filled by an elder who will instruct and direct the other two. Their tenure will last for the entire period of water scarcity.

Three households are exempted from the turns for *chu-dpon* and *lo-ra-pa* duties because they are responsible for other duties within the community. One belongs to the low caste blacksmith's household, as blacksmiths repair farm tools, free of charge, for the whole community. The other two households' responsibilities date from the time of the monarchy. One household is responsible for the organization of *sa-kha phye* and of the Ladakhi New Year festivity; the other is responsible for the village deities and has to perform a ritual once a year. Every house in the oasis pays a share of the cost of the *chu-dpon* in the form of grain and money. The amount of dues is fixed in proportion to the cultivated area owned.

The three *chu-dpon* play an essential role: they manage the irrigation system in accordance with traditional procedures. They supervise the water management in the oasis all day long. Their duty is to convey water up to the required plot. Thus, they are the only ones who are allowed to open and close diversion structures and reservoirs. They also have to inform the next water users of the availability of water, in order to maintain a good co-ordination. For the same reason, they check that the watering continues with no wasted time. They settle conflicts about water, and in case of violations of the rules they can impose a temporary suspension of water privileges. During their appointment, because of their influence and position, they are frequently invited by landholders to eat or drink local beer. This gives the opportunity for households to interfere and negotiate the timing of one's turn. *Chu-dpon* allow for a certain flexibility of the system, but as they themselves belong to the water user community and as the people dependent on them at the present time will one day themselves be *chu-dpon*, there is no abuse of authority.

Chu-dpon are responsible for the proper management of the irrigation system and should safeguard sufficient water resources for the community. On the full moon day of each Ladakhi month, from the second to the seventh month (corresponding to the agricultural labour season), the *chu-dpon* must take part in a ritual performed by a monk of Sabu for the spirits and deities of the village. They participate in order to ask them for plenty of water during the irrigation season. Muslims and Christians also participate when their turn comes to fulfil the function of *chu-dpon*. This ritual is accomplished at the foot of the holy tree of the village, at the upper part of the oasis. All households are involved, each having to contribute a piece of butter and a plate of flour, which will be used to prepare the offerings.

Water Distribution Schedule After the Floods

The scarcity period is finished after the arrival of the flood, *chu-phel*; from then on there is sufficient water to simultaneously fill all the main canals.

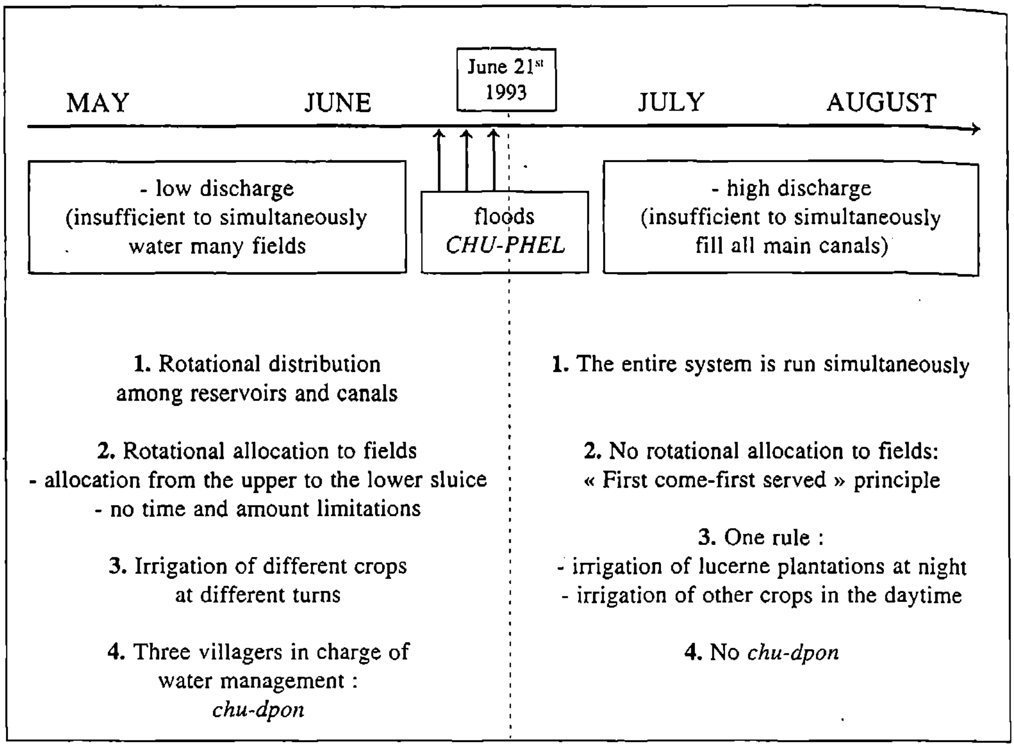

June 21st 1993
MAY
JUNE
JULY
AUGUST
- low discharge (insufficient to simultaneously water many fields
floods
CHU-PHEL
- high discharge (insufficient to simultaneously fill all main canals)
1. Rotational distribution among reservoirs and canals
2. Rotational allocation to fields
- allocation from the upper to the lower sluice
- no time and amount limitations
3. Irrigation of different crops at different turns
4. Three villagers in charge of water management : chu-dpon
1. The entire system is run simultaneously
2. No rotational allocation to fields: « First come-first served » principle
3. One rule :
- irrigation of lucerne plantations at night
- irrigation of other crops in the daytime
4. No chu-dpon

Fig. 11.8: The two phases of water management in Sabu oasis.

Each intake diverts one part of the flow. At this point, the rotational schedule for reservoirs and canals is over. The *chu-dpon* are no longer in charge after the floods arrive and water users manage the reservoirs by themselves.

Water Allocation to Fields

After the floods arrive, water distribution no longer follows a sequence of watering from higher to lower fields in each canal. The "first come—first served" principle is now prevalent. Despite a relative abundance in water, problems may still occur during this period. On Sundays, a day off for all employees, for example, everybody is free for fieldwork and water demand is higher than on other days. Sometimes, water is diverted upstream, stopping the irrigation below. These kinds of situations can lead to conflict, especially as there is no *chu-dpon*. If serious quarrels do occur, such cases are submitted to the headman or to his assistants for settlement.

Rules and Strategies

The only remaining rule concerns the irrigation of lucerne. The night flow is allotted for this fodder crop. Every house with lucerne plantations is entitled, in turn, to one or two "nights of water". As before, the list for the turn is based on the order of sluices along the canal, from the upper to the lower. If necessary, water users may exchange their turns based on their own agreements. Day flow is allotted to all cultivations except for lucerne.

Surplus water at the end of each irrigated field is called *zhabs-chu,* "water falling at the feet". *Zhabs-chu* may sometimes be used by the water user to circumvent the rules. For example, landowners of fields contiguous to lucerne plantations can use *zhabs-chu* to flood lucerne during daytime, while irrigating the field.

CONCLUSION

The irrigation system presented in this paper is located in an arid environment. For that reason, one might expect irrigation water to be shared and used in a highly restrictive way. The example of Sabu shows us that this is not actually the case. Initially during the rotational distribution period, water allotment to the fields is carried out without time limits or limitations of volume. Water application to fields is performed using a technique which implies substantial wastage. Violations of the rules, such as stealing water, do not result in harsh punishment. Summing up, we could say that a critical gap between water supply and demand does not exist at the present time or on a network-wide scale. If necessary, the system could be shifted towards a more economical and efficient use of water by changing the irrigation technique and applying more severe allocation rules.

Furthermore, the irrigation system of Sabu allows for some flexibility which can be seen from year to year. In case of scarce winter snowfalls, for example, the *chu-dpon* apply rules more severely and do not hesitate to suspend water privileges of disobedient villagers.

The community has adjusted the system gradually to social and economic changes. The way in which *chu-dpon* are appointed has changed over the last few years. The irrigation network is said to have been operated a few years ago by two elders elected for their abilities. As there was frequently difficulty in getting villagers to accept this job, a turn system among all the houses was set up. The community decided to appoint two assistant *chu-dpon* according to a list while a third one would be elected.

At present, water management is a factor in the social cohesion within the community of Sabu. It reinforces community bonds by creating interdependence among water users. Social cohesion arising from irrigation practice remains strong because all responsibilities are shared at the community level. Facilities maintenance and management of the water turn and of the conflicts are in the hands of the villagers. Cohesion is also apparent through agricultural activities; co-operation and communal management of the cultivated area are frequent practices.

In this case study, water management is not a factor for the emergence of any kind of permanent authority. *Chu-dpon* derive their temporary powers from the community and the responsibilities they hold do not last longer than the season of water shortage. In any case, power circulates among the households. In addition, economic and social status has no influence on water management. Water is allocated according to a turn system which is based only on the relative location of one's fields along the canal. The duration of the entitlement depends on factors such as the features of each field and of the water supply at the time of irrigation. All houses must also contribute equally to the maintenance of the irrigation system and to agrarian rituals. Households are not equal with regard to landholding and social status, yet a principle of equity guides access to common resources and prevails over the use of irrigation water.

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NOTES

1. This study is based on fieldwork carried out during the cultivation season of 1993 and completed in 1996.
2. The above-mentioned data were recorded at the meteorological station of Leh.
3. For example, discharge values were 9300 m^3 per second in August 1977 and 12,800 m^3 per second in August 1980 (average based on ten days). Data recorded by the Stakna Hydel Project.
4. See for instance: Cunningham 1854: 103–108.
5. Through lack of equipment, we do not have discharge measurements at our disposal. The irregular shape of the streambed makes a rough estimation even difficult.
6. For further information about household organization in Ladakh, see, Dollfus 1989.
7. The kanal system is used for area measurement by the State officials. Twenty kanals are equivalent to one hectare.

8. In some north-facing oases, another practice is reported. After the autumn ploughing, villagers may apply water to their fields. This water is freezing and is stored in this state during the winter to be released when it thaws. It then replaces *skya-chu* for which villagers would have to wait a longer time because of the late thawing of snow patches in mountains facing north. It is known as *khyags-chu*, "frozen water".
9. The border length depends on the nature of the soil. On the Indus plain, soil is of clayey texture. For that reason (permeability of clayey soil is lower), borders can be long. Consequently, there is only one line of borders in the fields of the Indus oases.
10. The clockwise direction is the direction followed by Tibetan Buddhists when they worship.

12

Farmer Participation in Irrigation Management in State-sponsored Minor Irrigation Systems in the Indian Himalayas

Andrew E. Manzardo

> Efforts should be made to involve farmers progressively in various aspects of management of irrigation systems, particularly in water distribution and collection of water rates. It is now widely recognized that without the active involvement of beneficiaries in irrigation water management, the objectives of irrigation projects could not be realized and even if they are realized, they cannot be sustained in the long run.[1]
>
> *The National Water Policy of India*

INTRODUCTION

Although there are water user groups currently involved in the management of literally hundreds of traditional irrigation schemes in India,[2] irrigation schemes that are either totally farmer managed or involve farmer participation in some aspect of system management cover less than 1 per cent of the total irrigated area of the country.[3] In order to increase this number, farmers would have to be given a greater role in the management of state sponsored irrigation.[4]

The reasons for increasing farmer participation in irrigation management have been widely discussed and generally centre in the following areas:

- relief to the government of part of the costs and burden of system management (especially minor maintenance, rule enforcement and the solving of water disputes),

- improvement of system performance due to increased co-operation between farmers,
- improvement of micro-network system maintenance, and
- improvement equity of water distribution.

In spite of this discussion, many technicians seem unconvinced of the value of user participation in state sponsored irrigation, and some states continue to try to expand exertion of government control over the management of an ever increasing number of systems (in some cases even attempting to expand their control into existing adequately managed traditional systems), in spite of the fact that their staff is now often overburdened and their budget is often inadequate to provide services to systems already under their control.

In characterizing the current situation of irrigation management in India, M.S. Reddy of the Central Water Commission of the Government of India Ministry of Water Resources notes that:

> Criticism is often voiced that the existing structure of the Irrigation Department in the states is not consistent with the end objective of increased productivity of irrigated agriculture. It does not envisage functional specialization or motivate the efficient use of water from the source to the farm. There is minimal contact with farmers. The reach beyond the government outlets is seemingly no man's land in respect of responsibility. It is excluded from the purview of the Irrigation Department nor is any other agency fully in charge of it. The farmers are not in full control of the reach to enable collective community organization.[5]

Here, Mr Reddy has put his finger on one of the major problems in irrigation management in India today. Although there has been support for the creation of water user associations in state supported systems, and although these associations have been shown to increase system efficiency, *the formation of water user associations, alone, often have not been sufficient to establish more effective irrigation management.* What is needed is the establishment of regular interaction between these farmer organizations and government staff and the development of on-going linkages between farmers and government staff.

The formation of water user groups themselves has not proved to be a difficult undertaking. Farmers have been shown to be quite willing to co-operate and will shoulder reasonable burdens if it can be shown that they will increase their chances of receiving adequate water within a crop year. The more difficult step has been in convincing government engineers to co-operate. Although the Government of India strongly supports farmer participation in irrigation management, the present procedures, rules and regulations of irrigation departments normally are not conducive to fostering this type of joint responsibility in India. There still remains the problem of establishing confidence and finding a bridge between two groups whose status differences have separated them for a thousand years.

The need for a change from the present "government-centred" management procedures has been made more urgent by a sharp increase in the number of systems which now have to be managed. Increased reliance on irrigation has been one of India's solutions to the problem of the ever increasing demand for higher agricultural production; leading to the construction of many new state sponsored irrigation systems of all sizes during the last three decades. This has led to a situation of near paralysis in some existing irrigation management bureaucracies, with total funding for system maintenance remaining static, water charges insufficient to cover operating costs and personnel levels that cannot be expanded.

In addition, while the number of systems has increased, the cost of maintaining each individual system has also increased. In such circumstances, now increasingly common, more is being demanded of departments with fewer budgetary resources available. Government is now being asked magically to make ends meet. At some point, maintenance costs will outstrip funding and irrigation systems will seriously deteriorate, leading inevitably to a sharp decrease in agricultural production.

The only possible solution to the problem is to bring the users themselves into the management equation. Many in government have viewed user participation as only one of many optional solutions to these problems, but given the economic realities of government, from where else but the users can the additional needed resources and support come? Although everyone recognizes that substantial changes in procedures, rules and regulations of irrigation departments will be required, before the situation can be improved, the crucial question is how such change can be brought about?[6]

The Central Water Commission report, *An Approach to Organizational and Procedural Changes in the Irrigation Sector* points out, however, that the solution is still far away in terms of day-to-day system management.

> The link between the irrigation departments and the farmers is still in an indirect manner and the studies on all possible variations are in a formative stage. While there are numerous traditional and experimental approaches the variety and complexity of the interface between government bureaucracies and farmers requires many additional adaptive trial and error approaches.[7]

Since the type and size of irrigation may vary within states and certainly varies between states, and since India's peoples vary in their socio-economic systems, their economic conditions and their ecological milieu, discussion on this issue, as noted by the report, "...should look at decentralization and turnover in the context of key characteristics and ingredients of successful trials without attempting to suggest a universal, modular solution."[8]

The Hill Area Land and Water Development Project, discussed in this paper, provides one successful pilot attempt at increasing the farmer's role in the management of state sponsored minor irrigation, demonstrates to the government the value of user participation in irrigation planning and management, and demonstrates a method for institutionalizing the linkage between farmers and departmental staff.

THE HILL AREAS LAND AND WATER DEVELOPMENT PROJECT

The USAID-assisted Hill Areas Land and Water Development Project (HALWDP) in Himachal Pradesh was begun in 1984 and was intended to last for seven years; ending in December 1991. The Project was extended for an additional year, so that its actual termination date was December 1992.

Five departments were responsible for the physical implementation of irrigation systems in the state under the Project. Three were responsible of physical works on the irrigation systems themselves, namely: Irrigation and Public Health (IPH), the Agriculture Department (AD), and the Rural Development Department (RD) through IPH. Together, under the Project, these agencies constructed or improved 879 small irrigation systems in ten districts. In addition, the Forestry Department was responsible for carrying out two essential, but complementary tasks; constructing and planting environmental protection works surrounding the systems: first, to protect the systems from damage from the potentially unstable mountain environment and second to protect the environment from the changes brought about through the construction of the systems. Finally, the Horticulture Department, along with the Agriculture Department and the universities[9] acted to deliver extension to help farmers adapt their methods to the new opportunities and responsibilities of irrigated agriculture. These agencies with Project support, produced an integrated programme of system development, institutions development, extension and training taking many important steps toward transforming Himachal Pradesh into irrigated agricultural economy.

Under HALWDP, three major types of irrigation systems were constructed: *flow irrigation* schemes, *lift irrigation* schemes, and *tank irrigation* schemes. A few tubewells were also drilled in valley areas.

None of the HALWDP *flow schemes* were newly constructed. Rather, work on these schemes involved repair, rehabilitation and extension of existing traditional schemes. Many of these schemes, at one time or another, had fully functioning traditional irrigation management organizations, but as systems requiring Project support were badly damaged before the project began, traditional management systems were no longer functioning in most of the schemes with which HALWDP was involved.[10]

Whether it was the breakdown of the systems or of the organizations, which came first, depends on the situation. Either of these scenarios might have occurred in various places. Coward points out, for example, that many of flow schemes in Himachal Pradesh were built by independent hill rajahs. As their power diminished after the Raj, their ability to oversee and lend legitimacy to the traditional management systems of these canals also diminished. This power vacuum led some of the more powerful high-caste farmers to feel they could grab more than their share of water on some systems, leading to other farmers' withdrawal of their support from participation in system management. This, in some cases, led to system breakdown and a loss of irrigation efficiency due either to conflict or a lack of maintenance. In this case the breakdown of the organization led to a breakdown of the irrigation system.

In other cases, a large natural disaster might have occurred which could not be repaired without support from the treasury of the local rajah (himself often in decline), or without aid from the state or national government which replaced him (itself with limited resources often not yet made available to minor irrigation). Such accidents could knock out an entire irrigation system, permanently. In this case, the irrigation system, dies first eliminating the need for the organization which supported it.

Both cases have occurred repeatedly in Himachal Pradesh, yet both scenarios have a common ultimate cause; the death of the traditional ruling system which initiated and underpinned the original irrigation systems.

Where local cultural integrity has been maintained, farmers have been able to maintain *both* their traditional organizations and the physical integrity of their systems, but as these systems were functioning well they needed neither repair nor organizational support from HALWDP and are thus not included in our sample. *Flow schemes identified for USAID support were those suffering from prior damage due to accident or deterioration beyond the ability of the local communities or the government to repair.* Aid was given to return damaged flow schemes to full function or to extend their command area or improve at field channel command (or *chak*) distribution.

Tank irrigation schemes, lift irrigation and *tubewells*, on the other hand, involved the building of entirely *new* systems. This, in turn, required the establishment of entirely new management systems; ones that could ensure the continuing operation and maintenance of pressure valves, ascending mains, electric pumps and other high cost, high tech items, as well as the irrigation channels. Needless to say, there was a great range of opinion as to how such management could be carried out.

In all schemes, however, the existence of the traditional farmer associations had little relation to the farmer's ability to participate in system operations once the system was rehabilitated by the Project. A drawback for such large-scale projects is that they sometimes have a tendency to stress the governmental point of view (since the donors themselves are most often government agencies), and these, in turn, work best with other government agencies. Aid is thus channelled from one government agency to another, often leaving those outside of the government (here the farmers) outside of the transaction. Reflexively, such agencies move to control that which they build (and *repair* or *rehabilitation* often automatically becomes equated with *building* in government *projects*). Under such situations, as soon as the local government agency repairs or rehabilitates a traditional irrigation system, from its point of view, the system becomes "magically transformed" into a "government-run system" and is placed in a realm of quite murky law, quite far from the traditions with which the farmer might already be accustomed. This absorption of systems into the government realm has no sinister purpose; it is merely a governmental habit, a *legal gradient*, if you will.

Once the traditional system slips into this murky underworld of such *de facto* government ownership, it falls into the hands of the "government officials" who claim to take responsibility for its operation, and who often feel that somehow they have actually taken control of it in reality.

This transfer of *de facto* responsibility has two unfortunate results. First, many farmers accept the situation at face value and cease to feel ownership and responsibility for the irrigation system leading them to abuse the system by stealing water and avoiding maintenance work. This attitude is characterized by the statement, "The government owns the system, let it be therefore responsible for it."

Second, in the end, the government doesn't really want responsibility for the day-to-day operation of such systems and really has no resources to actually manage them. If they try to take responsibility, they soon find that the additional burden overwhelms them with enforcement demands and they soon run out of maintenance money. Both the farmer and the government servant are soon at loggerheads and the system rapidly deteriorates.

It is clear that both farmers and government have a role in minor irrigation in maintaining both newly built and freshly rehabilitated systems, but what has proved most difficult is to allow each of them to find their own place within the scheme of things, to find respect for each others place and to accept the necessity of a proper division of labour between them. *The engineers and other government agents had to be convinced of the ability of the farmer to successfully participate in system management and to help government develop ways of successfully interacting with them.*

The first indicator of the problem came in the initial phase of Project execution between 1984 and 1990. New systems and rehabilitation activities were designed by the concerned government departments, approved by USAID and started, long before any farmer organization activities began. Farmer input into design and construction was minimal. Once construction began, some schemes were left uncompleted as plans encountered inherent design flaws or engineers ran into conflict with farmers, who claimed the proposed networks of field channels were inadequate or that the channels also were poorly placed and/or poorly executed. Such conflict resulted in an ever-widening gap between the farmers and the engineering staff.

The lack of involvement of farmers in planning and decision-making had created a situation where farmers were reluctant to commit themselves to irrigated agriculture even where systems appeared to be nearing completion. Low operating voltage in power lines and motors breaking down without local means of repair, made some lift systems periodically inoperable during peak hours of water requirement. Farmers feared such failures and were reluctant to grow high value crops such as off-season vegetables. The poor performance of many of the more sophisticated sub-projects, especially lift-schemes, had not satisfied the expectations of the farmers, despite heavy investment. This poor performance made farmers reluctant to become involved in the operation and maintenance of these schemes, as they were afraid to become involved in the financial and technical burden of taking responsibility for the schemes.

Water systems built by the IPH were considered to be the property of the Government and farmers felt they had no individual responsibility for them. There was no systematic procedure for communication between farmers and implementing agencies and communication between farmers was inadequate. There was conflict and inequity in many schemes. Farmers used to routinely obstruct each other's canal water and those who were victimized had no recourse. When repairs were needed, each farmer had to establish his own relations with government staff. Repairs were made on the basis of these individual relationships.

To be fair, such problems were not the case in the smaller and simpler tank and flow systems developed by the Agriculture Department, where systems were immediately handed over to the farmer. In many cases, however, the farmers' inadequate management skills made it difficult for them to take full advantage even of these small and simple schemes.

Evidence of the intractability of the older government attitude toward farmers and their insistence on solving their own problems without farmers can be found in how long it took for the Project to correct things.

ORGANIZATION OF THE FARMER ORGANIZATION DEVELOPMENT PROGRAMME

By early 1990, the HALWDP Project management was looking for solutions to these difficulties. The Farmer Organization Development Programme developed by consultants to the World Bank-supported Mahakali Project and Irrigation Sector Support Project and the Government of Nepal came to their attention in April and a programme was proposed to meet the needs of Himachal.

The programme was finalized in the fall of 1990. It was expected:

- To support the development of farmer organizations and develop a *regular system of interaction* between farmer groups and the government technicians through the establishment of a methodology for joint problem-solving, management and co-operative activities, meant to grow in each community through the implementation of phased series of mediated activities aimed at strengthening the farmers' confidence *in their own institutions* and building skills to enable them to participate in further joint irrigation activities.
- To provide facilitators at the field level to act as conduits for this communication until more regular channels became established.
- To provide government officers with community action skills through classroom training and guided participation in joint confidence-building activities, enabling them to work more effectively together.
- To expand this proposed system of interaction through a series of steps: starting first in a selected project pilot area; then expanding to cover the remainder of the Project area; finally, through the institutionalization of the system through the remainder of the state.
- To improve both farming and management skills of farmers and technical staff through the establishment of extension training programmes geared specifically to issues of irrigated agricultural extension and water management.

Initially, the most difficult hurdle for HALWDP was to identify and select a staff for the FODP. In Nepal, this problem was solved by hiring contract employees to carry out co-ordination, supervision and implementation activities for a fixed period utilizing Project funds.[11] In India, it was decided that staffing for FODP would be provided from regular and daily wage government staff from the Agriculture Department. USAID agreed to cover the cost of the pilot programme to the government. The Project established the Farmer Organization Development Programme (FODP) by the end of 1990. Although staffed by the Department of Agriculture, the unit reported directly to the Project Cell or co-ordination unit of HALWDP. FODP was purely a project entity in its first year. The unit was considered a pilot agency, temporarily established to give FODP a chance to prove itself. It was assumed that if the method proved its value as a pilot programme, further expansion and institutionalization would be carried out and a regular government agency would be established in the future.

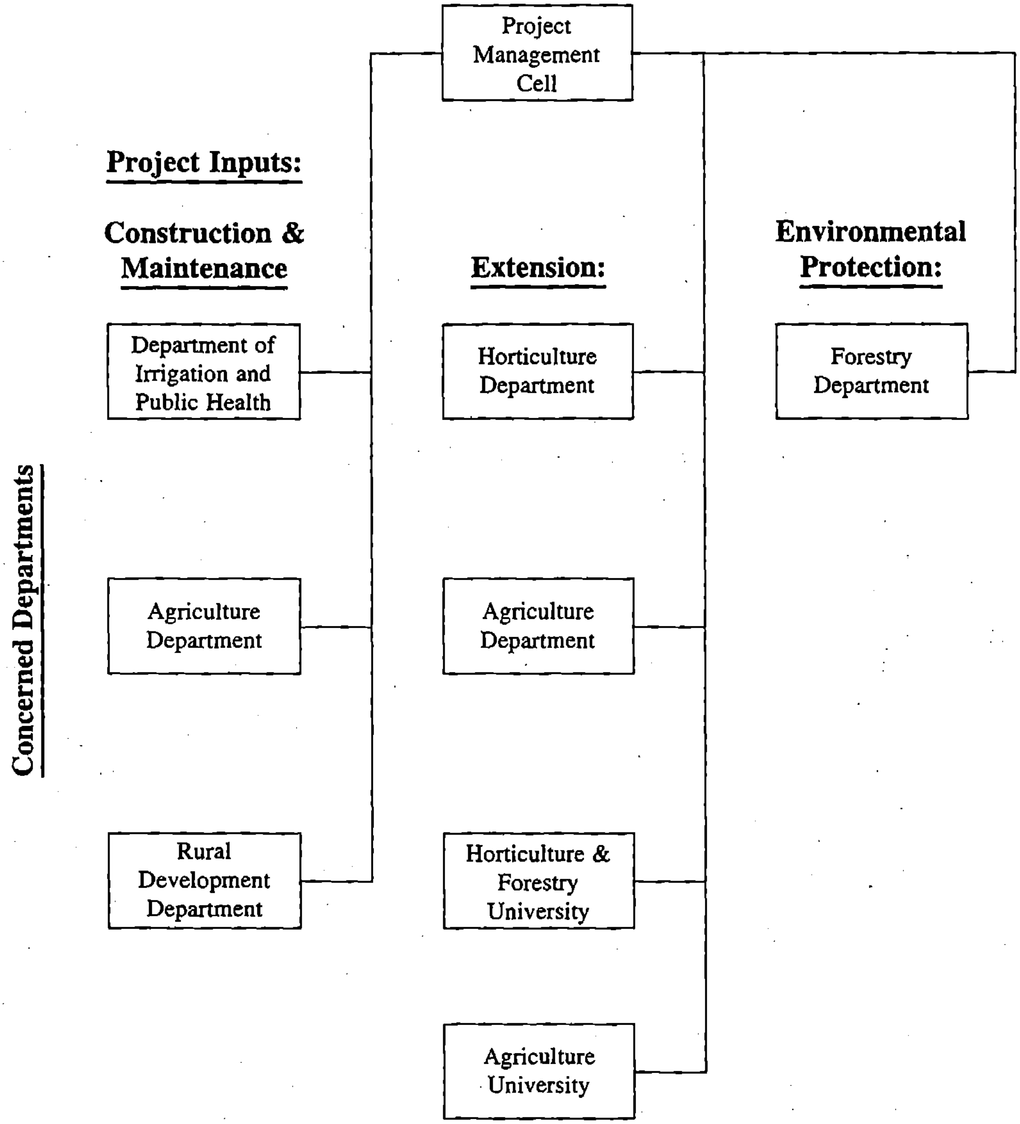
FODP consisted of *three* levels of organization, namely:

- A co-ordination level, a Co-ordinating Officer (CO), who was a Deputy Director of Agriculture, was given responsibility for managing the unit, with power to modify the programme, and for mediating at the highest level between the irrigation department and the farmer organizations, as well as for training programme personnel and farmer leaders;
- A supervisory level, two Department of Agriculture Subject Matter Specialists (SMSs) and six Assistant Development Officers (ADOs) were trained to oversee and direct field-level implementers in their daily work, who could provide mediation between mid-level irrigation department staff and farmer organizations at the district level and could provide on-going training for field level personnel and farmers and could review field level activities and report to the co-ordinator, and
- An implementation level consisting of twenty-three Village Extension Officers (VEOs) provided by the Department of Agriculture as field level organizers. These implementers lived and worked in farm communities, provided organizational support to farmers beginning to carry out management activities and mediation between low level irrigation department staff and farmer organizations at the sub-project level. A schematic diagram indicating the unit structure is given as Fig. 12.1.

Basic staff training was largely completed by March 1991. Initial training was held for FODP staff, followed by diagnostic training meant to assess weak points in staff understanding and performance. This again was followed immediately with remedial training meant to correct misunderstandings. Diagnostic training was given by two consultants already familiar with work in farmer organization development in Nepal. It should be pointed out, however, that FODP training (both new topics and refresher training) was more or less continuous throughout the remainder of HALWDP.

Twenty-six schemes were selected as pilot or "model" schemes on which the pilot programme in farmer organization development was to be applied. VEOs were trained and posted to each scheme to work as local level facilitators at the field level meant to foster interaction between farmers and government agencies and to help farmers' organize their own water users' association. One ADO supervised four VEOs in the same location. One SMS in turn supervised three ADOs and was responsible for the twelve

Figure 12.1: The Institutional Structure of the Hill Area Land and Water Development Project



VEOs under those ADOs. The CO, in turn, oversaw all activities in the State and was responsible for planning all activities in the programme. Support in training and planning was given to the CO by means of technical assistance supplied through a long-term advisor and two short-term consultants.

HISTORICAL OVERVIEW OF THE FODP

In past projects (such as the World-Bank sponsored Mahakali Project or the Irrigation Line of Credit Projects in Nepal), farmer organization programming has generally been divided into *two* broad categories of programming:

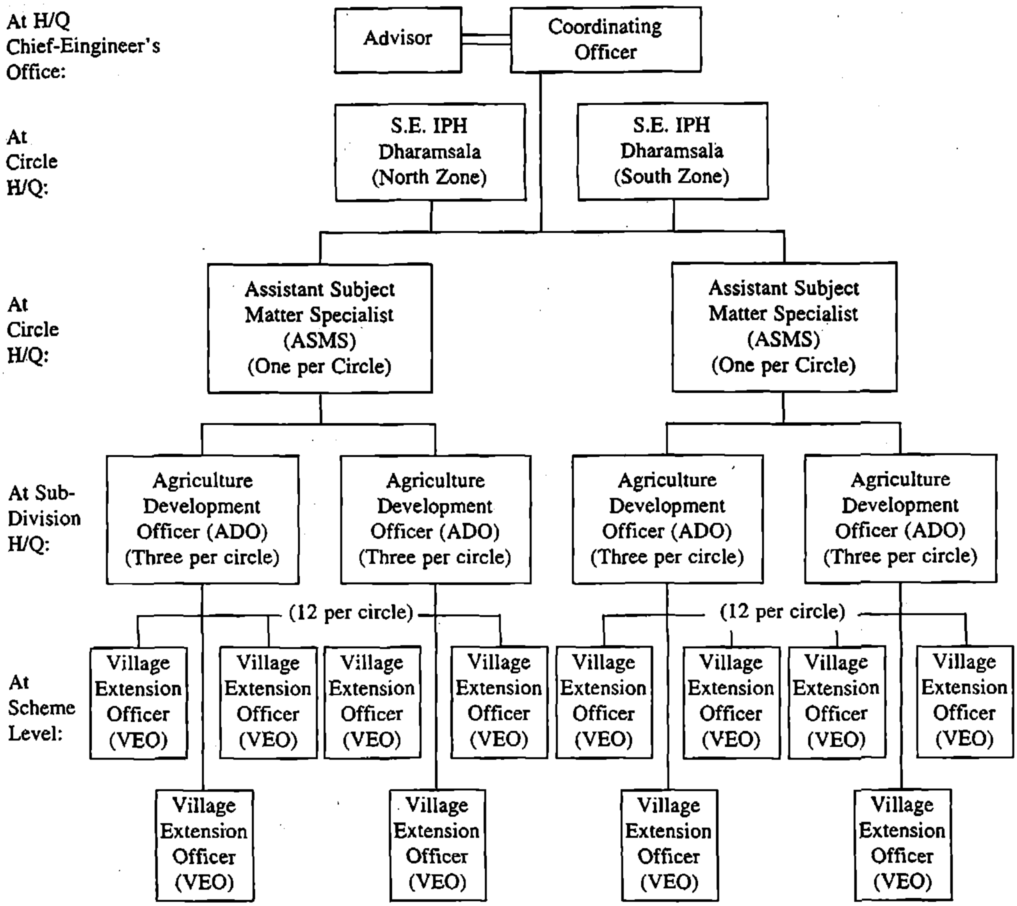
- new projects – *projects where farmer participation and an integrated approach is followed from the project's identification through until the post completion turnover*, and
- remedial projects – *projects which have been physically completed with little or no farmer participation in either selection, design or construction; such activities require problem solving and systems corrections where construction has taken place without farmer input and intervention to correct perceived or actual system shortcomings.*

By March 1991, when the FODP was fielded, nearly all the sub-projects at HALWDP were more than half-complete. The short period remaining before the projected completion date of HALWDP (at that time December 1991) meant that further new construction was not being considered by USAID.[12] Since all FODP activities started late in the Project, all pilot activities had to be carried out on projects which were physically quite far advanced and where many mistakes had already been made. All farmer organization development activities were therefore remedial, with no new projects to experiment with in HALWDP.

Twenty-four out of over 850 authorized sub-projects were selected for FODP pilot activities. These were termed "model" schemes, and were meant to act as experiments which would lead to models which could be used in a regular programme of farmer organization development throughout the State. These sub-projects were selected in two out of ten "irrigation districts" (termed "circles") of Himachal Pradesh (twelve in a North Zone "Circle" in Kangra and twelve in a South Zone "Circle" in Simla). Sub-projects in this pilot phase were limited to these two circles to avoid the logistical headaches of VEOs scattered throughout a large and mountainous state such as Himachal, limiting the area needed to be supervised by the small pilot staff. Sixty-eight villages were covered in this pilot programme, effecting about 4056 households.

In order to provide a wide selection of project types to enable FODP to gain experience working with all types irrigation in Himachal Pradesh, the proportion of sub-projects being implemented by each of the three participating construction agencies in the overall project was maintained in the sample (eight of the selected schemes were AD schemes and sixteen were IPH/RD). Similarly, the proportion of sub-project types (seven *lift*

Figure 12.2: Farmer Organization Development Cell: Hill Area Land and Water Development Project


At H/Q Chief-Eingineer's Office:
Advisor
Coordinating Officer
At Circle H/Q:
S.E. IPH Dharamsala (North Zone)
S.E. IPH Dharamsala (South Zone)
At Circle H/Q:
Assistant Subject Matter Specialist (ASMS) (One per Circle)
Assistant Subject Matter Specialist (ASMS) (One per Circle)
At Sub-Division H/Q:
Agriculture Development Officer (ADO) (Three per circle)
Agriculture Development Officer (ADO) (Three per circle)
Agriculture Development Officer (ADO) (Three per circle)
Agriculture Development Officer (ADO) (Three per circle)
(12 per circle)
(12 per circle)
At Scheme Level:
Village Extension Officer (VEO)

Coordinating Officer (C.O)	1
Asstt. Subject Matter Specialist (ASMS)	2
Agriculture Development Officer (ADO)	6
Village Extension Officer (VEO)	24
Staffing totals	33

irrigation schemes, four *tank irrigation* schemes and fourteen *flow irrigation* systems) was also reflected in the proportion of sub-projects selected. In addition, thirteen of the sub-projects were newly started by HALWDP, while eleven of the selected schemes existed prior to the Project. The proportion of new to old schemes also reflected the numerical composition of the Project as a whole, realizing, however, that *all* sub-projects *both new and old*, were nearly complete by the time the FODP programme started. Although some tubewells were being dug under the HALWDP in a limited area of the State, none existed in the FODP pilot areas of Kangra and Simla, so these were not included at this time.[13]

IMPLEMENTATION OF THE FARMERS ORGANIZATION DEVELOPMENT PROGRAMME

Once the staff was fielded, the procedure once developed for Nepal and redesigned for India was prepared both in Hindi and English, and reviewed with the Project staff. State implementing agencies were informed about the programme, its objectives, and their role in the programme through two workshops, one at Simla (for the South Zone) and other at Palampur (for the North Zone) as well as through a great many meetings with Project leadership and senior government officials.

The implementation unit, termed Village Extension Officers (VEOs) in Himachal Pradesh were sent to the pilot villages once all training was completed. They immediately began to contact the individual farmers at their homes in their assigned systems. Slowly but methodically the VEOs spread general information about FODP and the Project and its importance to the farmers. At the same time, the VEOs also began to familiarize themselves with the state of any existing farmer organizations in their area and with the problems facing them.[14] Out of 4056 households, about 3000 households on twenty-five systems was reached in this initial interaction.

Once farmers were willing, meetings were organized on each irrigation system regarding irrigation problems and their possible solutions. After identifying problems, the trained VEOs and their supervisors, the Agriculture Development Officers (ADOs), worked with groups of farmers to develop a strategy for organizing farmers from the chak to the system level.

The organizational structure adopted by each organization differed depending upon the conceptual and organizational model developed by the farmers themselves, and on the realities dictated by the size and ecological location of each system. *Farmers were encouraged to carry over the structure of their traditional irrigation organizations, wherever possible, into the structure of their new user groups enabling them to continue working in already familiar ways. On the other hand, these traditional* *organizations were being redesigned to carry out new activities, such as learning to work effectively with government agencies.*

Officers were selected by the farmers on each system and the membership of these organizations began to grow. As these groups evolved, multi-tiered organizations with large central committees began to evolve on the larger flow schemes; while the organizations of the smaller systems remained less formal and were more inclined to continue to include all members in day to day operations; although even the officers of the smaller organizations took on responsibility for many of the meetings with outsiders. Fourteen of the pilot farmer organizations have such informal all-inclusive structures, while eleven were complex enough to evolve into multi-tiered organizations.

Krishak Vikas Sangh (KVS) gradually became what farmers adopted as a title for these organizations. A formal assessment of system problems was carried out once the KVS organization was completed. Problems in the physical system were identified during contacts with individual farmers, through group meetings and through a process known as the "walk through".

A "walk through" is defined as *a joint tour of an irrigation system by farmers and responsible government staff to identify and determine the nature and causes of problems in the system, to prioritize them, agree to solutions and apportion responsibility for carrying out remedial tasks.* The HALWDP "walk through" included the staff of the implementing agency (IPH or AD), the KVS executive body and other interested organization members, as well as members of the FODP staff. The Project also supplied a USAID-sponsored team of consultant experts (through a unit called the Liaison and Co-ordination unit or LCU) was made available for "walk throughs" in the pilot phase. These consultants were provided as a resource team to provide technical advice.

The "walk through" became the centre of the Project's effort to improve communication with farmers and correct system flaws. It should be stressed, however, that many of the problems encountered in "walk throughs" were not new problems, but were corrections and repairs to work already carried out between 1984 and 1990. Although much of this work on these sub-projects was of good quality, many of the schemes still had small flaws, parts which were incomplete, poorly designed or badly constructed in the Project's earlier phase. Although these areas were small, corrections were necessary if the systems were to be successfully operated.[15] Lack of agreement over what was to be done and who was to do it led to poor communication and a lack of mutual esteem and confidence between farmers and government staff which, in turn, had led to project gridlock. It was the farmer organization development unit which helped re-establish communications between these groups and enable work to again move toward completion.

A list of problems was agreed upon, in order of priority, and responsibility for fixing each problem was allocated, in writing, at the end of each "walk through". The technical staff then prepared a design for any major corrections or repairs, if this was necessary, and prepared an overall cost estimate for approval by the concerned departments. Once approved by the implementing agency, estimates and designs were again shown to the KVS for their final approval.

An agreement was then made as to what share would be borne by the government and what by the KVS.[16] Initially, HALWDP provided some financial support out of project funds and technical design support to ensure the government's inputs would be quickly delivered. In almost all cases, the KVSs agreed to contribute unskilled labour as their input, but in a few schemes, the KVS agreed to pay a percentage of the actual cost of rehabilitation construction in cash.[17] Co-operation between the farmers and the government officers continued to improve as the fear that the other side might not deliver its share continued to diminish.[18]

To ensure the full participation of the KVS during construction and improve communication between the KVS and the implementing agencies, a process evolved known as the "preconstruction review meeting". In these meetings, both sides met to finalize each side's expectations and to review the final schedule of implementation for activities for each sub-project. By the end of the pilot phase (March 1992), all mutually agreed upon joint work was implemented, completed and certified in all twenty-five "model" schemes.

By February 1992, it was apparent that the farmer organizations could successfully hold up their side of the participatory management bargain in minor irrigation. Unfortunately, the Government buoyed up by the success of the pilot programme, underestimated the amount of preparation and training necessary both for farmers and government staff, to ensure the creation of further successful organizations, and decided to order, by fiat, the formation of farmer organizations in each of the remaining over 850 USAID-sponsored schemes. By September 1992, all of these organizations[19] had been registered, but the continued small size of the FODP (itself still a pilot organization made up of fewer than forty individuals) made it impossible to provide the necessary institutional support and training to such a large number of newly created farmer organizations and their government counterparts. For this reason, many of the new groups existed, but lacked a clear understanding of their purpose or how to obtain their goals.

Since farmer organization development work in HALWDP did not consist of forming new organizations, so much as facilitating communication between existing organizations or potentially existing ones and concerned government agencies, much training for farmer leaders under HALWDP consisted of how to work successfully with government officers. Similarly, most of the training for government officers consisted of building their confidence in farmers and their organizations. Although some last minute training was given to the officers of the newly formed organizations, familiarizing them with the nature and purposes of the KVS (which succeeded only in further whetting their appetite for more practical information on how to get things done), there was little or no time for further training of government officers.

Further expanded familiarization programmes were given in the two Agriculture Department Training Centres with support from Project consultants in mid-1992 and was continued after the USAID-funding ended (as late as mid-1993). Further training is scheduled to be provided to leaders of the newly formed KVSs through visits to the older KVSs on the model schemes. This would be a chance for the new leadership to learn from those who are already more experienced. This "farmer-to-farmer" training is considered a new approach to quickly share the experience of the few with the many and greatly increase what still remains a highly limited training pool for farmer organization in Himachal Pradesh.

In addition, a cadre of farmer organization development workers were trained from among the non-specialized agricultural VEOs in each participating district in mid-1992, along with the Deputy Directors of Agriculture and SMSs of the northern and southern zones, who have received both regional and district level training in farmer organization development methodologies, supported by the consultants and the acting Co-ordinator of the FODP, as well as training to help them extend a special package of agricultural practices specially tailored for irrigated agriculture in the agro-climatic zone of each VEO. This special package of practices was termed *Irrigated Agricultural Extension.*

Once they have received training, these SMSs, will train the VEOs and ADOs living in selected "additional model scheme" areas of their Districts to enable them to carry out work in farmer organization development and irrigated agricultural extension, once further funding can be obtained.

Through this type of training, gradually, FODP activities are being shifted from being the responsibility of a specialized unit to becoming the responsibility of the regular field level extension staff and the work with be taken over by the Department of Agriculture. The Department has explicitly accepted responsibility for FODP in the post Project period.

OPERATION AND MAINTENANCE SYSTEM DEVELOPMENT

The acting FODP Co-ordinator, a consultant engineer and the author developed a three level system to regularize and institutionalize the allocation of responsibility for maintenance activities among the farmers, the private sector and the IPH in support of the government decision to recognize registered farmer organizations and to formalize the farmer's role in system maintenance. Under this system three levels of potential interaction were proposed:

- First level repairs would consist the simplest repairs and maintenance and would be entirely the responsibility of the farmers themselves. Here the primary skills would be technical.
- Second level repairs would consist of works too technically complex for farmers where the KVS would hire local craftsmen to carry out repairs and maintenance paying them from farmer organization funds. Here the primary skills would be the resource mobilization skills of the KVS leadership (such as convincing a farmer on outlet one that he should assume part of the cost of repairs to outlet seven below his holdings).
- Third level repairs would consist of complex and expensive repairs or repairs of machinery not assigned to farmers which would be the responsibility of IPH to repair or replace. Intakes, pumps, motors and rising mains a lift schemes would fit under this latter category. In addition, second level repairs which constantly need to be made will be assumed to be the product of faulty design or upkeep and should be treated as a third level repair after a given number of recurrences. Here the primary skills would be the development of communications procedures and confidence building.

A committee of AD and IPH officers as well as the acting FODP Coordinator, a consultant engineer and the author,

- determined whether the draft guidelines presented required any modification to suit the needs and/or operating procedures of IPH and have translated those guidelines into Hindi.
- selected seven schemes: five "model" schemes and two "non-model" schemes and tested the methodology developed by the committee, along with consultations with KVS members, on the various systems, training farmers and IPH staff to implement the agreed upon procedures.

The committee completed its work, revising the proposed system according to the results of their field trail and according to the suggestions made by participating farmers. The findings were submitted to Government in early 1992 and the recommendations passed on to the Chief Minister of the Government.[20]

WATER LAW DEVELOPMENT

With the change in Government policy toward increased emphasis on self-help and private management and a growing emphasis on the privatization of small irrigation systems, the growth of the concept of investiture of at least part of the responsibility for the operation and maintenance of such state supported schemes in farmer organizations through participatory approaches is accelerating in Himachal Pradesh. The "walk through", the joint agreement, people's participation in system corrections through labour and cash contributions and system testing before turnover are now becoming fully accepted means of farmers and engineers working together in Himachal Pradesh. The establishment of a procedure for registering Krishak Vikas Sangh (KVS) under the Societies Act of 1860 and the order of the Secretary of IPH to carry out registration of organizations in all schemes have given an official sanction to this approach.

Government has agreed that registration under this Act should be looked upon only as a temporary measure; a first step on the road to the development of a more effective water law. It has been agreed that this act will serve only for the purposes of initial organization correction identification and farmer certification, but that further institutional development in the form of an effective revised water law is still needed before systems can effectively be handed over to farmers.

The lack of a more effective water law and an overall water policy for the State continues to be an impediment to the development of the irrigation sector of Himachal Pradesh. We have pointed out on other occasions that any legal revision should spell out system ownership or, at least, generate adequate usufructuary rights for irrigation organizations, while clarifying the rights and duties of both farmers and the Irrigation Department in system management.

Since all irrigation systems in Himachal are minor, progress in improving water laws of Himachal Pradesh has been made by returning to customary practice in many cases, as well as on depending on existing legal precedent. While it is too early to outline the proposed new laws, traditional management systems, readopted by farmers in their development of KVS structure during the Project's pilot phase, are being carried over into the proposed new laws; keeping in mind the need for maintaining the fit between user groups and the bureaucratic norms of government agencies. This will, in turn, permit the satisfactory further development of co-management, especially in the area of system operations and maintenance. HALWDP offered the Himachal government support in developing a new law.

CONCLUSIONS: THE DEVELOPMENT OF A COMPREHENSIVE APPROACH

The discussion above has shown some of the preliminary and experimental steps already taken by one state in the Indian Himalayas toward developing approaches for achieving increased agricultural production through participatory management in minor irrigation systems.

General experience in participatory management over the last two decades has shown that the formation of water user groups is, in itself, not sufficient to ensure sustainable farmer participation in irrigation management. Farmers lack the technical skills for certain types of maintenance and the resources for large repairs even in some of the simplest systems. Government support and some forms of joint management will be necessary if systems are to be sustained.

With few exceptions, however, the relations between farmers and irrigation department staff have been pretty well neglected. Differences in social class, years of poor relations, neglect and ignorance of each other have created a situation where there is little mutual trust between the two. Presently, however, the algebra of increasing demand for high agricultural production and decreasingly available budget for maintenance have thrown the two groups together, willy-nilly, to find a solution. Both, like it or not, are going to be increasingly part of a relationship that they will have to somehow develop or the system will fail.

The Hill Area Land and Water Development project experimented with a model for a system of confidence building and interaction between the groups and began the work of its institutionalization within the regular government system. Such a system requires the formation of a temporary group of facilitators to bring the groups together, mediate their differences and start them on a single set of tasks. Such an approach requires training for farmers, for irrigation staff and government officers. Mutually acceptable systems of work have to be developed and a legal and institutional structure established to protect the rights of those participating. HALWDP tried to handle each of these tasks simultaneously on a pilot level, and develop the training programmes and identify actors in order to expand the system to the government of the state as a whole.

The Project went further in making the major concepts of the methodology developed in HALWDP and the World Bank projects in Nepal available to the rest of India and the other countries of South Asia, through an interactive video disk (IVD) called *Working with Farmer Organizations* prepared by the Education Development Center of Newton, Massachusetts, through the USAID-supported Water Resources Management and Training project. The IVD provides basic training to junior-level engineers and others who must work with farmers as part of their activities to enable them to work effectively with farmers in a co-ordinated approach. This IVD will soon be available through Water and Land Management Institutes (WALMIs) in selected states in India.

Although first steps have been taken to develop comprehensive training programmes for participatory management in India, much work needs to be done. Generally speaking, it is in the development of training programmes teaching government staff and farmers how to work effectively together where much of the emphasis needs to be placed at present.

Experience in five programmes outside of India and in HALWDP has shown that a successful organization development programme has to be created specifically for the purpose of community organization. Initially, some sort of mediating unit is necessary to bring the various actors together. This is a full time activity and generally has not successfully been carried out, in the early phases at least, as a spare time activity for technical staff. Government extension staff, such as village extension officers, has also been used for this task. Community organizers have to be fully trained and prepared for their work to be successful. The mediating unit becomes less necessary as farmers get better organized and technical staff begins to better integrate their activities. The farmer organization unit can often drop out of work in one area to be used in new projects where organizing has just begun. Similarly, mediating units become less necessary as the number of farmer organizations grow and begin to successfully interact with technical staff. Since farmer organizations are often based on traditional models, they are quickly copied by other farmers and little instruction is needed once a sufficient number are developed in the field.

In the discussion above, it was argued that the ideal way to approach the necessity of increasing participatory management and improved linkage between farmers and government is through a comprehensive state-wide approach to water user group development, which simultaneously creates policy, organizational and procedural changes, carries out training and regulatory reform in a single integrated package.

Many Indian states already developed resources which they can call on to help in carrying out this task. Individual projects, certain government departments, Water and Land Management Institutes, state training institutions, universities and non-governmental organizations have all had some experience in water user association development. The examples in the discussion above shown how some of these agencies are now beginning to utilize this experience and what inputs they can provide for this work. None of these institutions, themselves, can single-handedly develop formal systems of interaction and a comprehensive state-wide approach to participatory management.

In the discussion above, it has been mentioned that the National Water Policy urges that farmers be increasingly brought into the management of irrigation systems. This is for reasons of equity, as well as efficiency. Such a policy cannot be effective for long in a pilot phase. The decision has to be made to begin to adopt wider reaching programmes, which encourage farmer involvement. In order to move from a pilot phase to a more comprehensive, implementation phase several initial steps are needed:

- First, states need to decide exactly how farmers are to be involved in irrigation management. This will be largely determined by the types of irrigation within the state, socio-economic conditions and local political factors.
- Second, states need to decide which agency will be responsible for developing and implementing comprehensive programmes.
- Third, a specific committee within that agency has to be given authority to carry out or assign necessary preliminary social analysis for the task and develop a plan and a timetable for development of a formal system of water user associations, a training programme for all who will interact (co-ordinators, supervisors, implementers, farmers and system staff), and a staffing policy (those needed to carry out training and implementation of the programme).
- Fourth, the timetable must be implemented and modified, as circumstance requires it, making necessary changes in the programme design and institutional support (regulations, staffing etc.) as circumstances require.

The discussion above has provided the reader with a review of the steps taken so far, to organize a comprehensive farmer organization development program in Himachal Pradesh. Because of the large number of small projects, the mountainous terrain and the concomitant poor communication and difficulties in travel in the state, the farmer organization development programme was implemented gradually, starting with a few pilot areas in two districts. The Department of Agriculture was given responsibility for the task. Village Extension Officers were used as community organizers. As experience was gained and more government officers were trained, the programme was spread, first to twelve additional projects throughout the state and then gradually to the remaining project areas. Training was also provided for farmer leaders and irrigation officials and regulatory reform was carried out as needed. Those carrying out the activities remained in constant touch with the government through co-ordination meetings with the Secretaries of Irrigation and Agriculture. The Director of Agriculture was briefed several times each week and took an active role in programme development. Local politicians joined in their support for the programme once they realized that conditions in irrigation were improving markedly in their constituencies.

The preceding example illustrates that an overall strategy, assigned to one agency, implemented gradually and modified according to experience, can increase farmer participation in irrigation on a state-wide basis within a very short period of time.

Although the solution described above has been a satisfactory solution for the problems encountered in working in Himachal Pradesh, differences between states and countries require that local conditions be scrutinized and taken into account before an approach to participatory management is developed in a particular situation. Experienced social scientists and community organizers are needed for this purpose and have been hired either directly through projects, or through alliances formed between government and non-governmental organizations or educational institutions. No single modular solution seems to have worked for all places and the study of water user group development in other countries and other Indian states could provide further guidance.

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NOTES

1. The Government of India, Ministry of Water Resources-CAD Division, *Farmers Participation in Irrigation Management*, R.S. Pathak, New Delhi, 1991.
2. In this paper, I am not concerned with traditional management systems, except in so far as they provide clues for the improvement of the Management State sponsored irrigation.

Rather, I am concerned with developing strategies for improving the management of state sponsored irrigation.

3. Central Water Commission, *An Approach to Organizational and Procedural Changes in the Irrigation Sector*, New Delhi, 1992: 48, fn. 21.
4. I derive my model for "state sponsored irrigation" from the large-scale irrigation systems of the ancient kingdoms of the Middle East. Several systems of this type predate the British Raj in India. The legal system under which irrigation is sponsored is derived from a set of regulations (Canal Acts) established under British rule which defined ownership of the systems, taxation, water distribution requirements etc. The minor irrigation systems established in the princely states which eventually became Himachal Pradesh have their own legal structures and traditions, but there is some degree of ambiguity between these traditional approaches and the acts established under British rule. This proves particularly troublesome in Himachal Pradesh, which became part of the Punjab once the princely states were absorbed into India after Partition. In the early 1960s the Punjab was divided into three states (Punjab, Hariyana and Himachal Pradesh) and the Punjabi canal acts, conceptually based on the management needs of the larger state run systems (even minor canals in the Punjab are larger than the small traditional irrigation systems of the Himachal Pradesh hills), were exported to Himachal without much modification (c.f. Himachal Pradesh Minor Canal Act of 1976). Because of this, there is still a tendency for the government to treat these minor systems, in legal terms, *as if they were big state run systems*. When the state has any role in rehabilitating or improving these systems, the legal gradient then moves toward converting such traditional systems to state sponsored systems at least in the eyes of the departments.
5. Government of India 1991: V.
6. Some attempts have been made to answer these questions in India. There are many clues, for example, to be taken from research into the management of some of the larger traditional systems in India. Government of India 1991: 53, for example, lists several examples of quite elaborate traditional systems in India, notably: the Cauvery Delta irrigation system, where 1505 A class channels and 19,000 kilometres of branch canals were kept clean and functional through "peoples' maintenance"; the Tambrapani irrigation system which involved farmers fully in the management of the system and still has several residual associations which have functioned for 120 years; and the Phad system of Maharashtra which functioned for over 200 years.
7. Government of India 1991: 45
8. Government of India 1991.
9. Two of the universities in Himachal Pradesh participated in the Hill Area Project in a programme of research and extension. These were the Y.S. Parmar University of Horticulture and Forestry near Solan and the Palampur University of Agriculture in Palampur.
10. *See*, Coward 1983 and 1990 for a discussion of traditional irrigation institutions in Himachal Pradesh and a discussion of the situation immediately prior to the beginning of the programme discussed in this paper.
11. Cf. Manzardo and Subedi 1990.
12. At that time USAID projected the project completion date as September 1991, Subsequently, HALWDP was extended by USAID through September 1992. Throughout this period all effort was placed on completion and/or correction of the over 850 projects already underway at the time the FODP programme began.
13. The development of methods of working with tubewell user groups has been proposed by Himachal Pradesh for work in a USAID-funded, ISPAN sponsored post project phase being considered at the time of this writing.

14. Many of the larger flow irrigation schemes or kuhls in Kangra already had traditional user organizations set up by the local maharajah or others at the time when the kuhl was built. At the time of the Project, many of these traditional user organizations continued to exist, but many were largely moribund. Although some were operating, many exhibited a certain lack of equity of water distribution along traditional lines of social dominance. These organizations were co-opted by the Project, wherever possible, in the hopes that the traditional organization could be reworked to enable them to successfully interact with government agencies; something which both traditional user organizations and government agencies had been unable to master before the advent of FODP. See, Coward 1983 and 1990 for a full description of this situation.
15. Corrections were necessary both in newly constructed lift schemes, tank schemes and tubewells as well as on system improvements to existing flow schemes. The need for system corrections was made more acute by errors and design flaws brought about by a lack of farmer participation in system design in the project's initial phase. The high cost of these corrections convinced many of the government officials of the necessity of joint design activities from a project's inception. Walk throughs have been built into the design phase of many of the World Bank projects in Nepal (c.f. Manzardo and Subedi 1990, and Reidinger, Radosevitch, and Manzardo 1991). In such projects farmers participate in the layout of secondary and tertiary canals and are able to warn engineers of drainage and other problems specific to their land before the system design is finalized. The farmer organization development programme was begun after much of the initial construction, let alone design, had been completed in HALWDP. System "corrections" were the only negotiable element still available at the time of this work. It should be stressed that it was these corrections that made the systems functional in the end.
16. It should be pointed out that the Project didn't need the farmers' contribution for financial reasons. Instead, the farmer share of the cost of these improvements was taken as an indicator of the farmer's support for the newly established arrangement. Likewise, such financial participation would have strong implications in assigning ownership to the systems at a later stage of FODP development; when these contributions, along with changes in the water law and the legal status of the group, could lead to increased and perhaps total farmer control of most systems as the legal structure of irrigation began to change in Himachal Pradesh. It was also felt that this shared cost responsibility would also lead to better construction quality on the sub-projects as the farmers would be interested in seeing that their money was being properly utilized. Also, it must not be forgotten that once the Project has left, financial support by the farmers would also most likely become a necessary component of maintenance support.
17. The farmers' share of cost of each scheme in cash and/or kind varied from two percent at the Chirnamti flow irrigation scheme to 34.8 per cent at the Panesh Kanda lift irrigation scheme. The average farmer contribution was about 11.5 per cent.
18. Project experience showed that in all cases where officials did not turn up for the "preconstruction review meetings", the basis for joint action had to be completely re-established and a new bargain had to be mediated between the groups by the FODP, On the other hand where "preconstruction review meetings" were successfully held, proper communication was fully established and both sides fulfilled their commitments to each other. Where the implementing agency started construction before holding a "preconstruction review meeting" with the KVS, the farmers did not fulfil their commitments when they were due. In the end, one cannot attribute successful joint action merely to these meetings. Rather, it is likely that successfully held meetings were indicative of successful co-ordination between the groups in other areas of interaction.

The review of agreement and a full review of the implementation schedule in the presence of all, however, did seem to be quite beneficial to the process of joint action.

19. It was decided by the Government of Himachal Pradesh to temporarily register these organizations under the Government of India Societies Registration Act of 1860, which gives legal standing to single purpose non-profit organizations. This act is not entirely suitable for this purpose as it does not allow the user groups to add other purposes to the organization, such as marketing of produce or purchasing of inputs, nor can the organization make a profit. The other alternative would have been to register the user groups under the Co-operatives Act, but this too is limited as the number of co-operatives which can be formed in a state, is limited by the statute and the required management and accounting procedures are tedious. It is evident that new legislation has to be enacted in India, which would set out the structure, rights and duties of water user associations. Himachal Pradesh registered the organizations under the Government of India Societies Registration Act as a temporary expedient, but they realize that new legislation is required.
20. The government agency in charge of irrigation development in Himachal Pradesh is the Department of Irrigation and Public Health. The "Public Health" in their title refers to the department's responsibility for providing drinking water to all communities within the state, an activity considered far more important than provision of irrigation facilities in this state. During a recent visit to farmer groups in the Simla District it was found that the duties of some of the groups were extended to cover responsibility for drinking water systems as well. Such an extension is quite reasonable in Himachal, as both the irrigation schemes and the water systems are fairly small scale and, in both, the bulk of the management involves distribution of water between community members, on-going maintenance and simple repairs. Larger scale repairs required liaison with the Department already established and regularized under the irrigation management programme described above. Farmers were called upon to provide labour and certain inputs for simple repairs and maintenance with the Department providing technical and design inputs, Department budget could then be targeted for much larger repairs in drinking water as well. These additional water supply management duties for user groups seems simple in retrospect, but it is significant that the engineers and user groups saw the utility of their groups in this area and were willing to extend their activities on their own, showing a strong potential for the utilization of such groups in water supply development and maintenance.

13

Irrigation in Dolpo: An Example of Water Management in a Steppic Zone of Northern Nepal

Corneille Jest & Marc Polge de Combret assisted by Trangmar Pema

INTRODUCTION[1]

Dolpo district lies on the north side of the main Himalayan divide. The area described in this paper is located in the northern part of Dolpo District, 28°50'– 29°30' North/ 82°45'– 83°25' East[2] (Fig. 13.1). The altitude ranges from 4000 to 5000 metres. Nepal receives most of its precipitation from monsoonal winds. The average annual rainfall amounts to more than 3000 millimetres south of the Himalayan range, on the contrary it is only 200 to 300 millimetres in the rain shadow north of the Himalayas. Therefore, in the upper zone of the High Himalayas, agriculture is only possible with irrigation. The only cereal cultivated is six-rowed naked barley[3]. At a lower altitude, below 3800 metres, buckwheat *(Fagopyrum tataricum,* and *Fagopyrum esculentum)*, mustard *(Raphanus sp.)* and potatoes (*Solanum tuberosum*) introduced in 1962 are the main products. Cattle breeding includes yaks, sheep and goats of Tibetan breed (Jest 1975).

THE VALLEY OF TARAP IN DOLPO DISTRICT, NORTHWEST NEPAL: ENVIRONMENT, POPULATION AND ACTIVITIES

Environment

The valley of Tarap, in Dolpo, furnishes a model for the analysis of water management in the arid zone of the Central Himalaya. The valley of Tarap

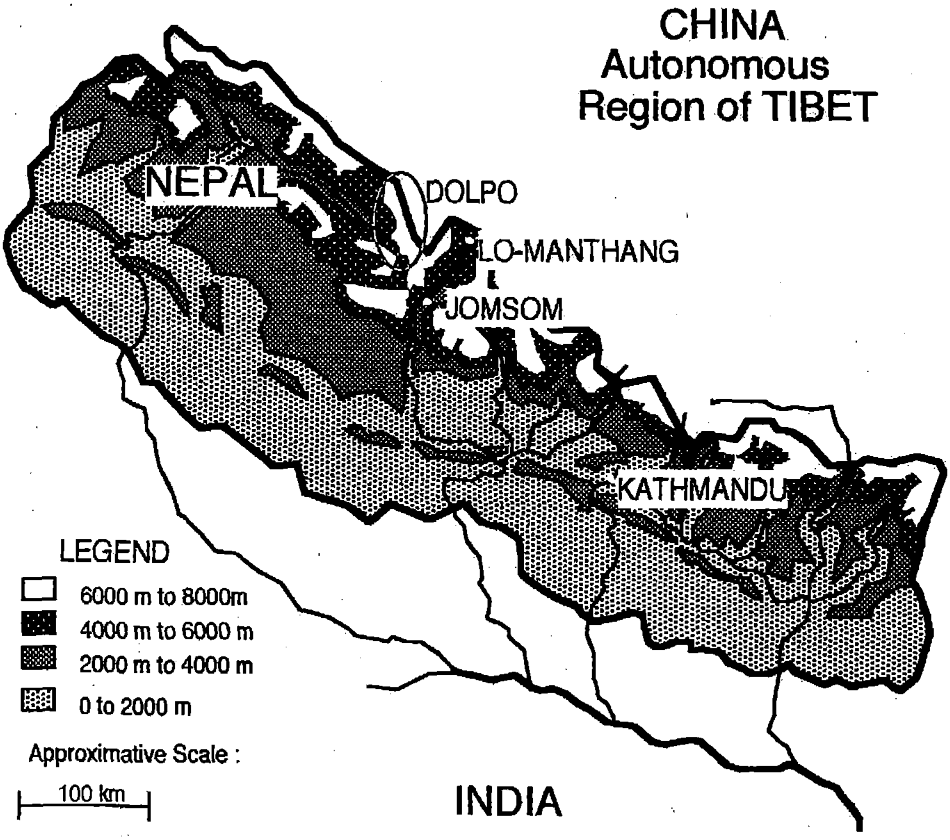
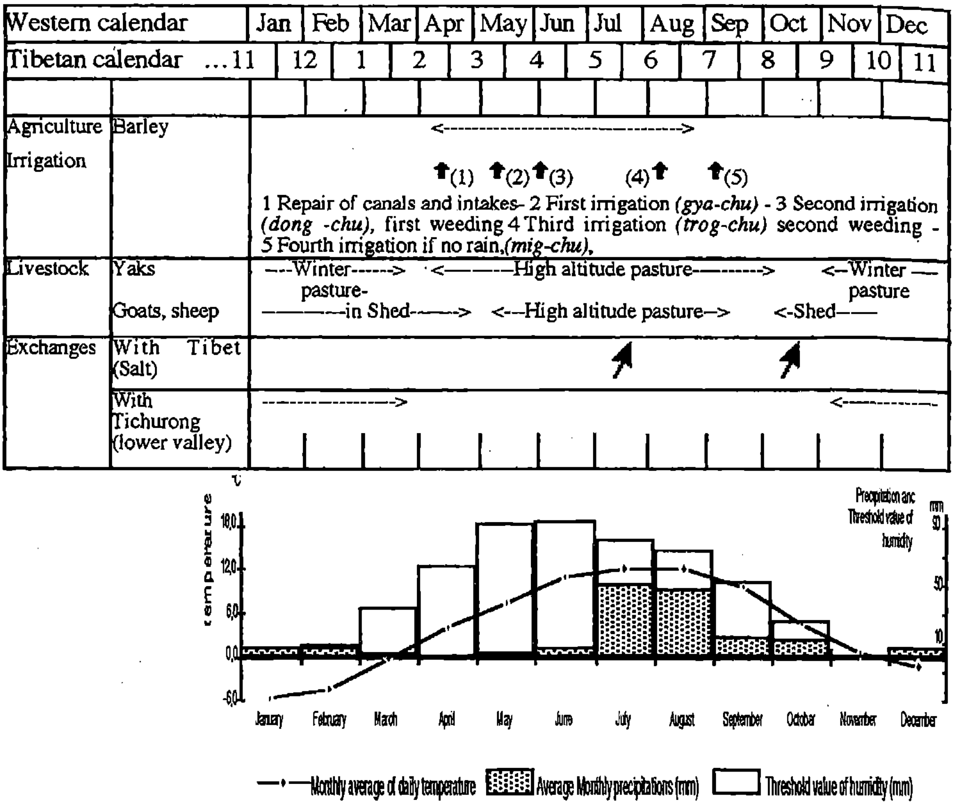


Figure 13.1: Map of Nepal.

is at an altitude of 4200 metres, and consists of the watersheds of the Tarap-Chu and Doro-Chu to their confluence and beyond toward the south; the width of the valley does not exceed 1000 metres and the slopes are steep (Fig. 13.3). Although Dolpo is located on the northern side of the Himalayan divide its weather regime is subject to the monsoon from June to August.

The climate is characterized by a cold winter and a short warm season from May to August. The precipitation is very low, less than 250 millimetres/year and is distributed almost equally between winter, in the form of snow and rain, and in summer (mid-June to mid-August), with hail storms during the months of August and September. Snow can fall during the harvest season, (see climatic records, Fig. 13.2 and Annex 2). Strong winds are common in summer and autumn which influence the evapo-transpiration. The soils of Tarap are very rich in coarse elements, coarse and thin sand, which explains why the soil may have a rather low water holding capacity[4]. It is also the reason why the soils are easy to work.



Western calendar		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tibetan calendar ...11		12	1	2	3	4	5	6	7	8	9	10	11
Agriculture Irrigation	Barley	<------------------------------> ↑(1) ↑(2)↑(3) (4)↑ ↑(5) 1 Repair of canals and intakes- 2 First irrigation *(gya-chu)* - 3 Second irrigation *(dong -chu)*, first weeding 4 Third irrigation *(trog-chu)* second weeding - 5 Fourth irrigation if no rain,*(mig-chu)*.											
Livestock	Yaks Goats, sheep	---Winter-----> pasture- <--------High altitude pasture--------> <--Winter — pasture ----------in Shed-----> <--High altitude pasture--> <-Shed——											
Exchanges	With Tibet (Salt)	↑ ↑											
	With Tichurong (lower valley)	---------------> <------------											

℃
temperature
18,0
12,0
6,0
0,0
-6,0
Precipitation and Threshold value of humidity
mm
90
50
10
January
February
March
April
May
June
July
August
September
October
November
December
Monthly average of daily temperature
Average Monthly precipitations (mm)
Threshold value of humidity (mm)

Figure 13.2: Calendar of the economic activities in Tarap and graph of temperatures and precipitation in Lo-Manthang.

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[1] Metrological data are not available for Dolpo, we quote here data evaluated using Lo-Manthang data (northern section of Mustang district) with a correction for temperature of 1 °C less for 300 meters high see Annex 2.

Population and Settlements

The population of Tarap numbers 500 persons of Tibetan language and culture. Three villages, Tok-kyu, Do and Lang are composed of a series of settlements located above the cultivated areas. The settlements comprise groups of from three to ten houses with enclosures for the animals. The settlement of Tok-Kyu is made up of the Khangar, Kätö, Shagyab, Champa Lhakang, Mondro, Tango, Chumaga, Kagar, Raytega groups, which are located on both sides of the Tok-kyu chu. The settlement of Do is comprised of Tsugtso, Londje, Tabza, Doro, and Shibchog. Lang is the third settlement on a side stream of the Tarap chu.

Agro-pastoral Activities

The way of life and beliefs of the inhabitants portray their Tibetan origin. The people of Tarap cultivate only one crop of barley a year. Some wild plants such as nettles, *Chenopodium album* and the roots of *Potentilla*, milk products and meat supplement the diet. The villagers rear yaks, Tibetan dwarf cattle, sheep, goats and horses. Livestock defines both their livelihood and their status.

In this region, where arable land is not sufficient, survival depends upon a supplementary source of income, in this case the barter trade with Tibet (Jest 1975: 160–164). Transactions take place in a yearly calendar, starting from spring as follows:

- first stage: local barley is taken by yak and sheep caravans to Tibet and bartered for rock-salt, wool, yak hair, butter, cheese, and livestock,
- second stage: the inhabitants of Tarap barter Tibetan salt and wool for rice, wheat, maize, buckwheat, millet, spices with inhabitants from valleys located to the south of Dolpo,
- third stage: the inhabitants of Tarap and Dolpo go to the middle hills in winter and barter salt for local cereals at a very favourable rate. They also sell horses.

In recent years, trade has been adapted to new types of consumer goods; salt, wool and yak hair, however, remain the major items of barter.

THE IRRIGATION NETWORK OF THE VALLEY OF TARAP

Hydrography of the Valley, and the Location of Irrigation Canals

As has been mentioned, the cultivation of barley is only possible with irrigation for its entire growing cycle (Fig. 13.3 and Tab. 13.1). Water is tapped from streams fed by melting snow and ice, which remains on the northern slopes above 5000 metres, and is distributed through a network of canals to the fields located on alluvial terraces on both sides of the streams. The natural slope of the terraces is gentle and does not require major intervention by man.

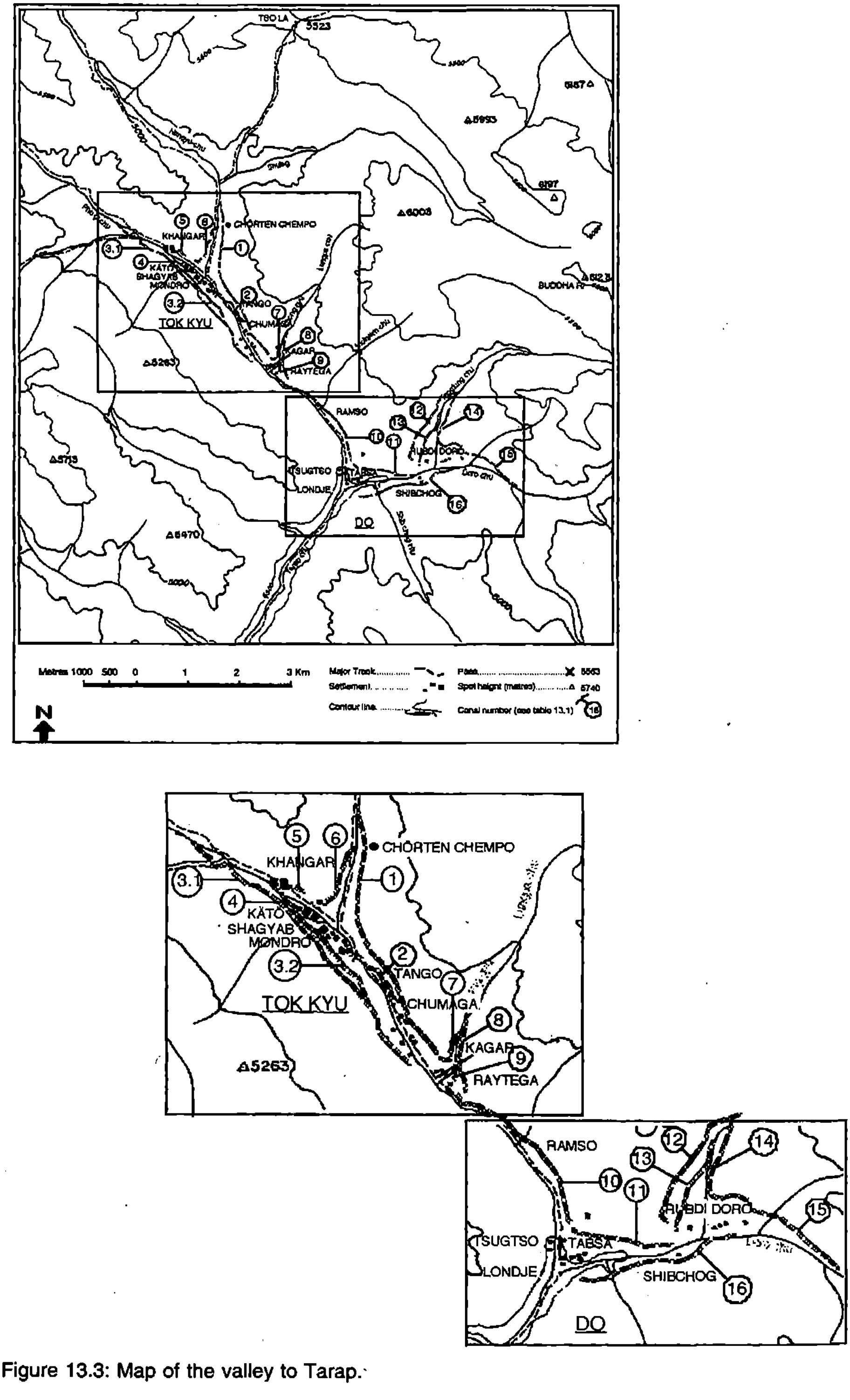

Figure 13.3: Map of the valley to Tarap.

Tab. 13.1
Irrigation canals in Tarap

No.	Canals in Tok-Kyu	Surface *Möndor*	Number of households *Thaka*	Duration of irrigation of the whole Command area Days
1	Yura Gong	40+		
2	Yura Og	45+		
3.1	Shagyab Yura Gong	30	8	
3.2	Shagyab Yura Og	50	20	
4	S. Kätö Yura	4	6	
5	Üma Yura	6	4	
6	Uri Yura	5	3	
7	Bago Kagar	7	6	irrigated if water available
8	Raitega Gong	5	3	irrigated if water available
9	Raitega Og	10	9	irrigated if water available
	Canals in Do			
10	Kagar Og/Dowa Yura	77	36	7+4+4
11	Gya'Ying Yura	40	15	7
12	Rubdi Gong (Tö)	10	10	
13	Rubdi Og	20	40+	
14	Doro Og	29	7	7
15	Doro Phu	24	7	7
16	Shibchog		6[a]	8
	Canals in Lang		19	
17	Gyachö Yura	23		
18	Sumdo	15		
19	Kirting Yura	10		
20	Ta Yura	10		

a) In addition, each house of the village of Do has at least one field in Shibchog
The numbers in column 1 refer to Fig. 13.3.

The unit of measurement of a cultivated area is the *möndor* (literally "a pair of plough-yaks"), an area which can be ploughed by a pair of yaks in one day: the equivalent of 0.05 hectare. The number of *möndor* possessed is an indicator of a household's wealth.

The Canals in Tok-Kyu

The fields are located on both sides of the Tarap-Chu on terraces 2 to 60 metres above the river bed. Most of the area is irrigated by 4 canals:

On the left bank: – Yura gong (Number 1),
– Yura og (Number 2)
On the right bank:– Shargyab Yura (Number 3): subdivided into two branches.

Yura gong, "the upper canal" (Number 1)

This canal has an approximate length of 3.5 to 4 kilometres. The intake is in the river bed of the Nangye-Chu (altitude 4360 metres asl). The headworks consist of a diversion structure: a wall of boulders and stones built in the middle of the stream which divides it into two branches. This type of construction was designed because of the long duration of unpredicted frequent flooding in the stream above the intake. The intake is situated on the left branch, which acts as an escape structure, diverting any overflow back towards the stream (Fig. 13.4).

The first secondary canal waters the lower terraces at Peling; the main canal, 300 metres below, dominates the terraces of the Tarap-Chu. A complex network of canals irrigates the fields of the upper terrace. All the secondary canals end at drains on the edge of the terrace before reaching the stream below. From the intake to the upper-irrigated terrace, the slope of the canal is approximately 1.1 per cent. Further down, the main canal reaches a lower terrace with a 4.5 per cent slope (on the last 800 metres of the canal) and joins the network of the Yura-og canal.

In 1985, the villagers tried to extend the main canal to reach the fields of Kagar further downstream. The attempt failed because of the nature of the soil and the very steep slope of the mountain. The length of the canal had to

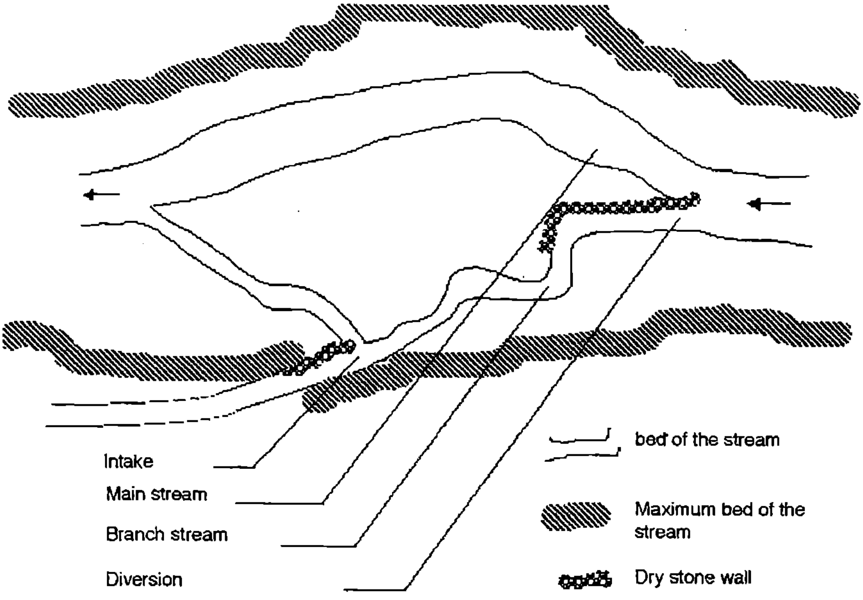

Figure 13.4: Sketch of a canal headwork.

be dug out of a schistous soil and passes through a very porous area which affected the stability of the structure when it crossed natural gullies and very steep slopes.

Yura og "the lower canal" (Number 2)

The Yura-og canal has an approximate length of two kilometres. The intake of the Yura-og canal is located on the Tarap-Chu, with a temporary dam made of stones. The idle length of 1.2 kilometres of the canal is cut along the side of the terrace. The command area of the system is located downstream of this portion and is watered by an impressive network of secondary and tertiary canals. The existence of a water-mill should be mentioned. It was built on the canal in 1990. An agreement between the builder and the community gives a strict priority to irrigation[5].

Shagyab yura, "behind the marshy land" (Numbers 3.1 and 3.2)

The total length of the canal is approximately 3.5 kilometres. The intake is on the right bank of the Phu-Chu/Tarap-Chu above, the group of houses at Kangar (4350 metres altitude). The average slope is 2 per cent. After an idle length of one kilometre, the canal subdivides in two branches (two water shares) :

- Yura gong (Number 3.1) (the upper canal) slope 2 per cent,
- Yura og (Number 3.2) (the lower canal) slope 3 per cent.

They join again one kilometre downstream (contour level of 4310 m). The area between ten and twenty meters above the stream bed is dominated by the canal which has been extended by one kilometre to reach the lower houses on the right bank of the stream.

Smaller canals

There are smaller canals (Numbers 4, 5 and 6) which irrigate a few fields in the river bed near Uri, Uma and Kätö. Three small canals have been built on the Chöngyu lungpa-chu, which flows down from the Buddha-ri ridge above Kagar. On the right bank, one canal (Number 7) irrigates the fields of Babgo and the enclosures, *yül-ra,* of Kagar. On the left bank two canals (Numbers 8 and 9) irrigate the fields around the houses of Raytega.

The Canals in Do

Kagar Og/Dowa Yura, "canal under Kagar leading to Do" (Number 10)

The Kagar og/Dowa yura canal (Number 10) flows through the territory of Tok-kyu for part of its length and irrigates a small area, Ramso, on Tok-Kyu territory before reaching Do. The intake is located on the Tarap-Chu below the houses of Kagar (4245 metres altitude) on the left bank. The first 200 metres of the canal are in the river bed and the idle length is approximately one and a half kilometres, the average slope is 1.4 per cent. The canal feeds three distinct areas:

• Ramso-Tö in Tok-Kyu	*Möndor*	12.
• Ramso-Og in Tok-Kyu	*Möndor*	15.
• Tsi-Gong in Do	*Möndor*	50.

Gya'ying yura "canal of the large fields"(Number 11)

The Gya'ying yura canal (Number 11) irrigates the lower fields of Do. The intake is on the Doro-chu, opposite Shibshog. The length of the canal is approximately two kilometres. Part of the idle length runs along a very unstable slope.

The ancient site of Rubdi is irrigated by two canals (Numbers 12 and 13) the intakes are in the Tsoglung-chu.

The fields of the village of Doro are irrigated by two canals (Numbers 14 and 15):

- the Doro og (Number 14), intake on the Tsoglung-chu, which gets the first water-turn before the Rubdi canal,
- the Doro-phu or Charkö lungpi-yura canal (Number 15) with its intake on the Charkö lungpi-chu.

The fields of Shibshog on the left bank of the Doro-chu are irrigated with water diverted from the Doro-chu (Number 16).

The Canals in Lang

There are four canals (Numbers 17, 18, 19 and 20) in Lang providing water to the fields, located near the confluence of two small streams.

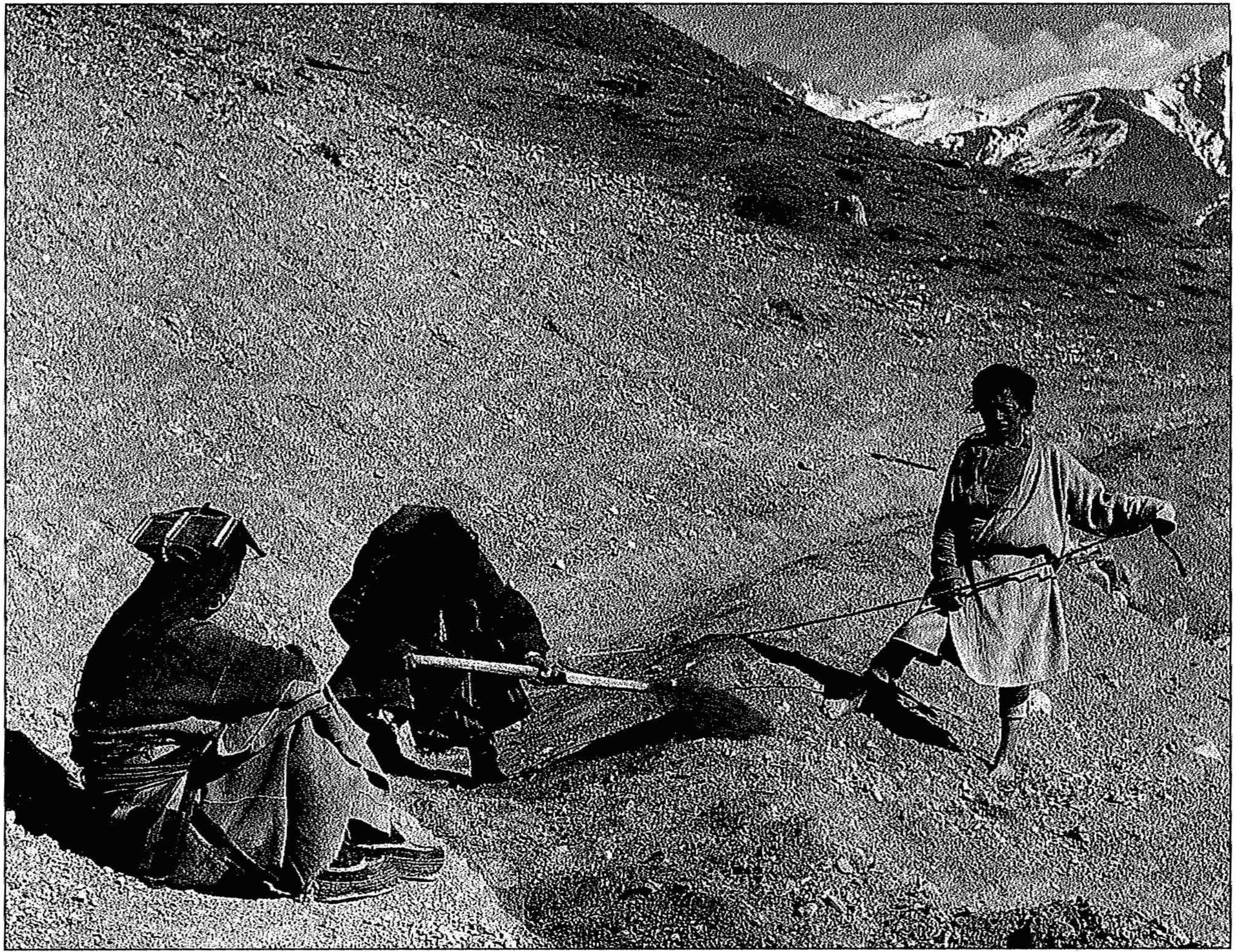

Photo 13.1: Tarap. Maintenance of the canal before beginning cultivation (Corneille Jest 1960).

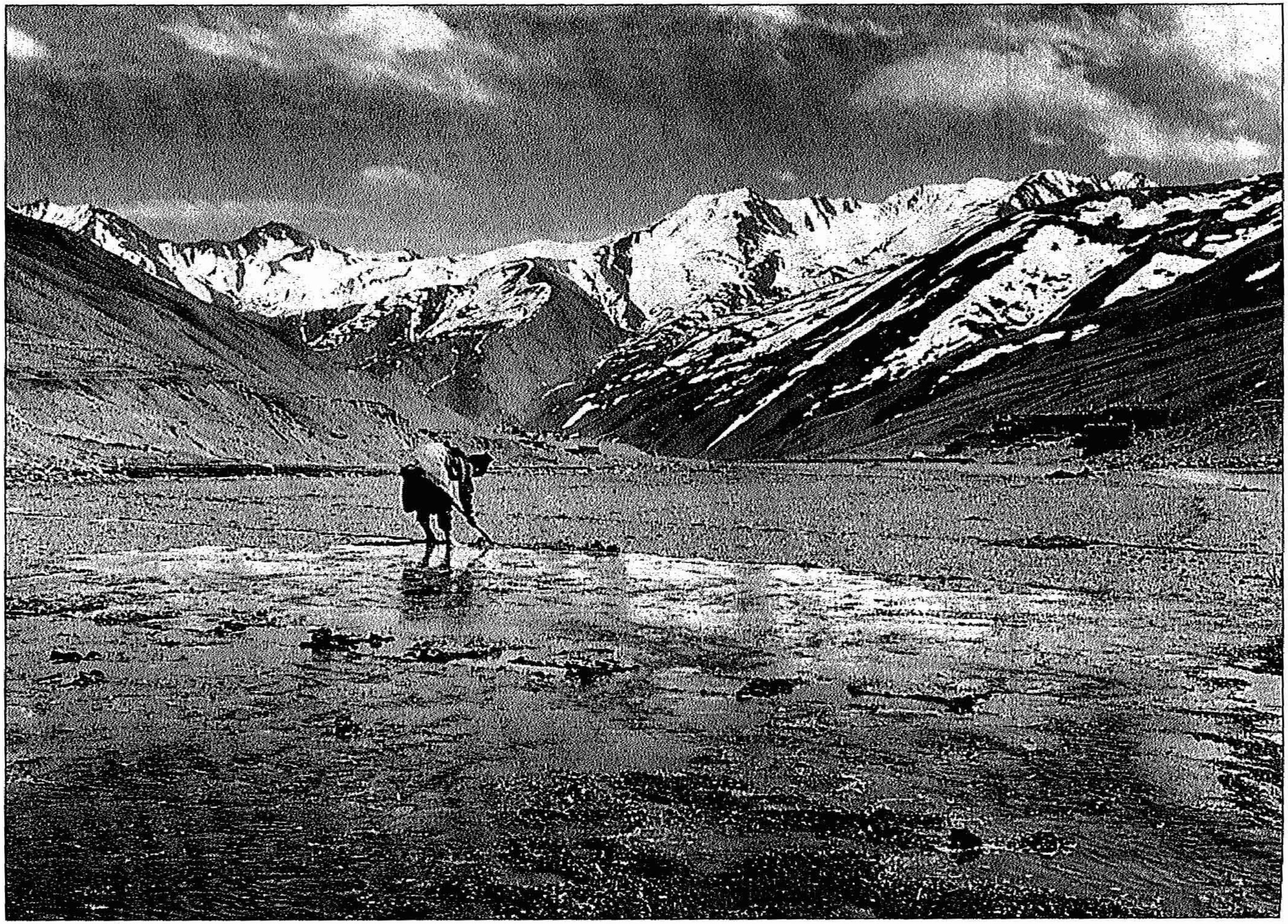

Photo 13.2: Tarap. First irrigation to moisten the soil (Corneille Jest 1960).

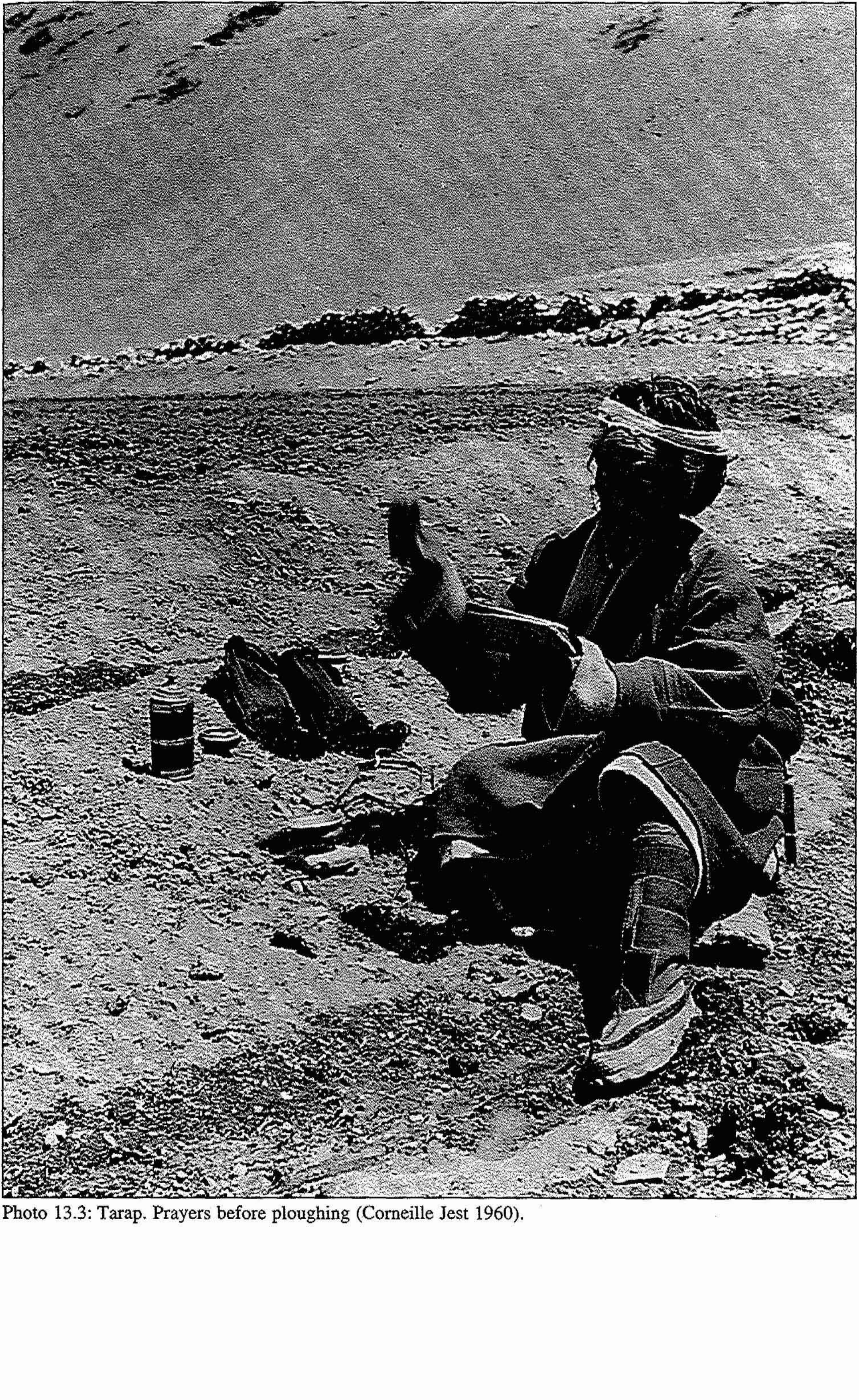

Photo 13.3: Tarap. Prayers before ploughing (Corneille Jest 1960).

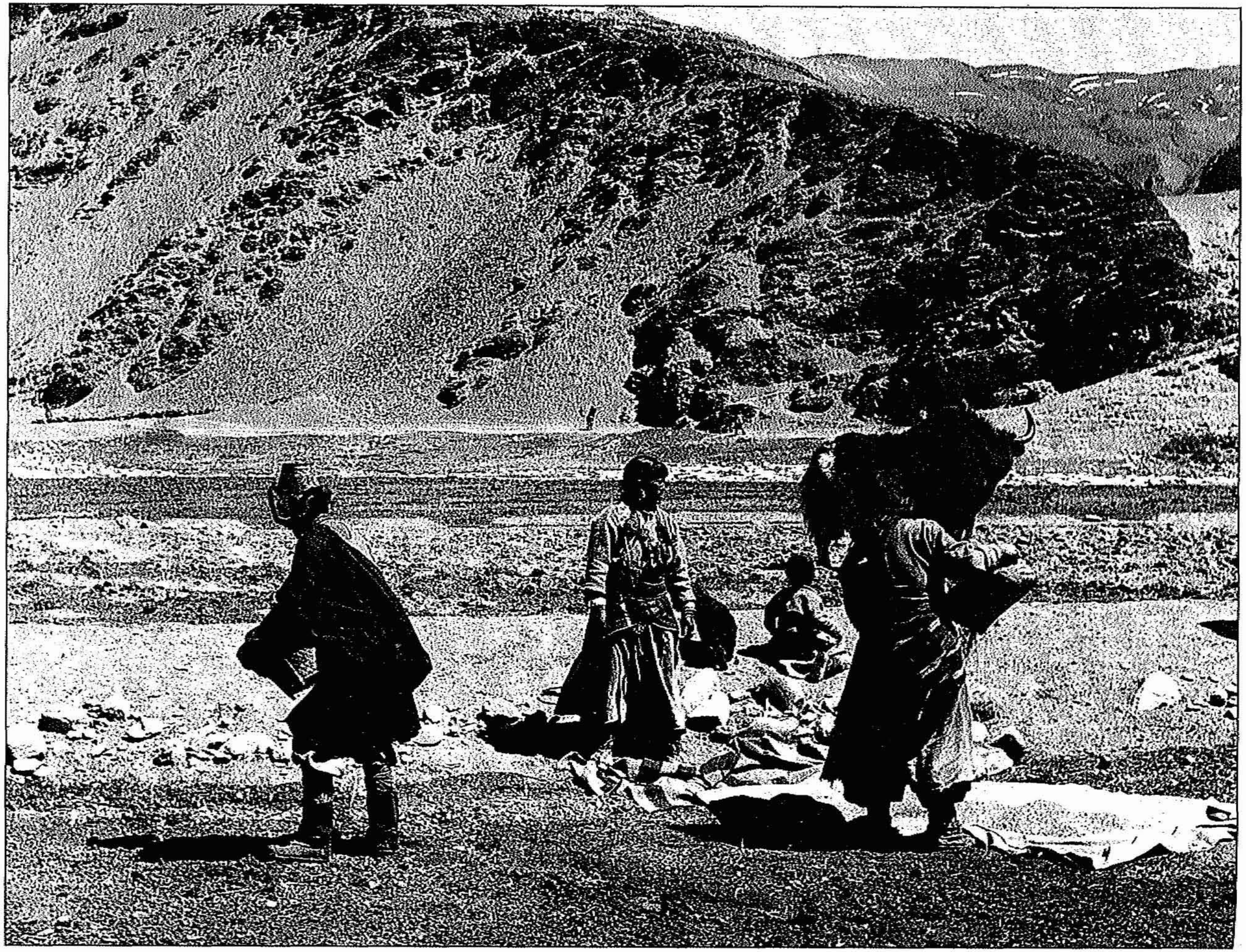

Photo 13.4: Tarap. Sowing of barley by the owner of the fields (Corneille Jest 1960).

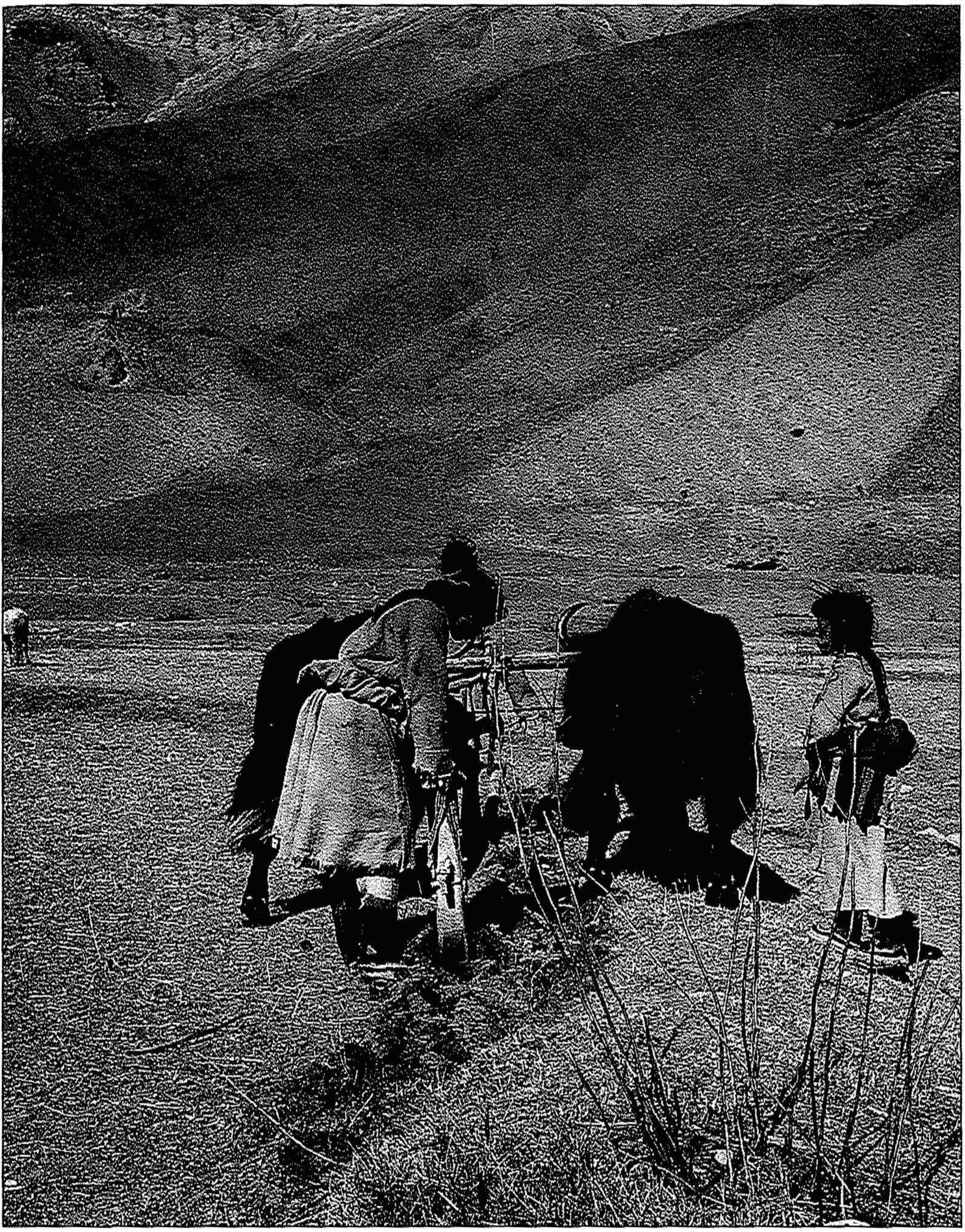

Photo 13.5: Tarap. Ploughing with yaks to cover the seeds from the upper to the lower part of the field (Corneille Jest 1960).

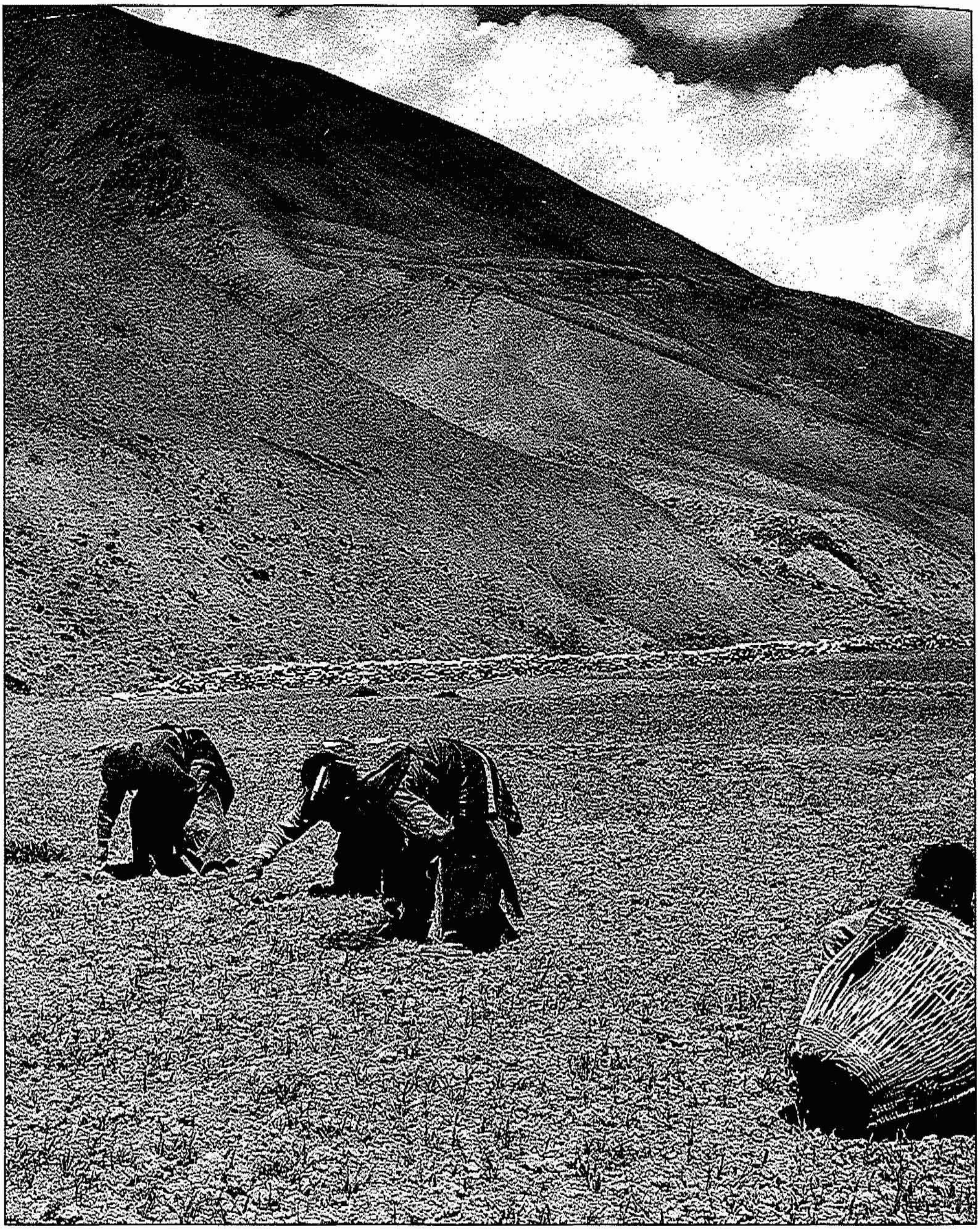

Photo 13.6: Tarap. First weeding (Corneille Jest 1960).

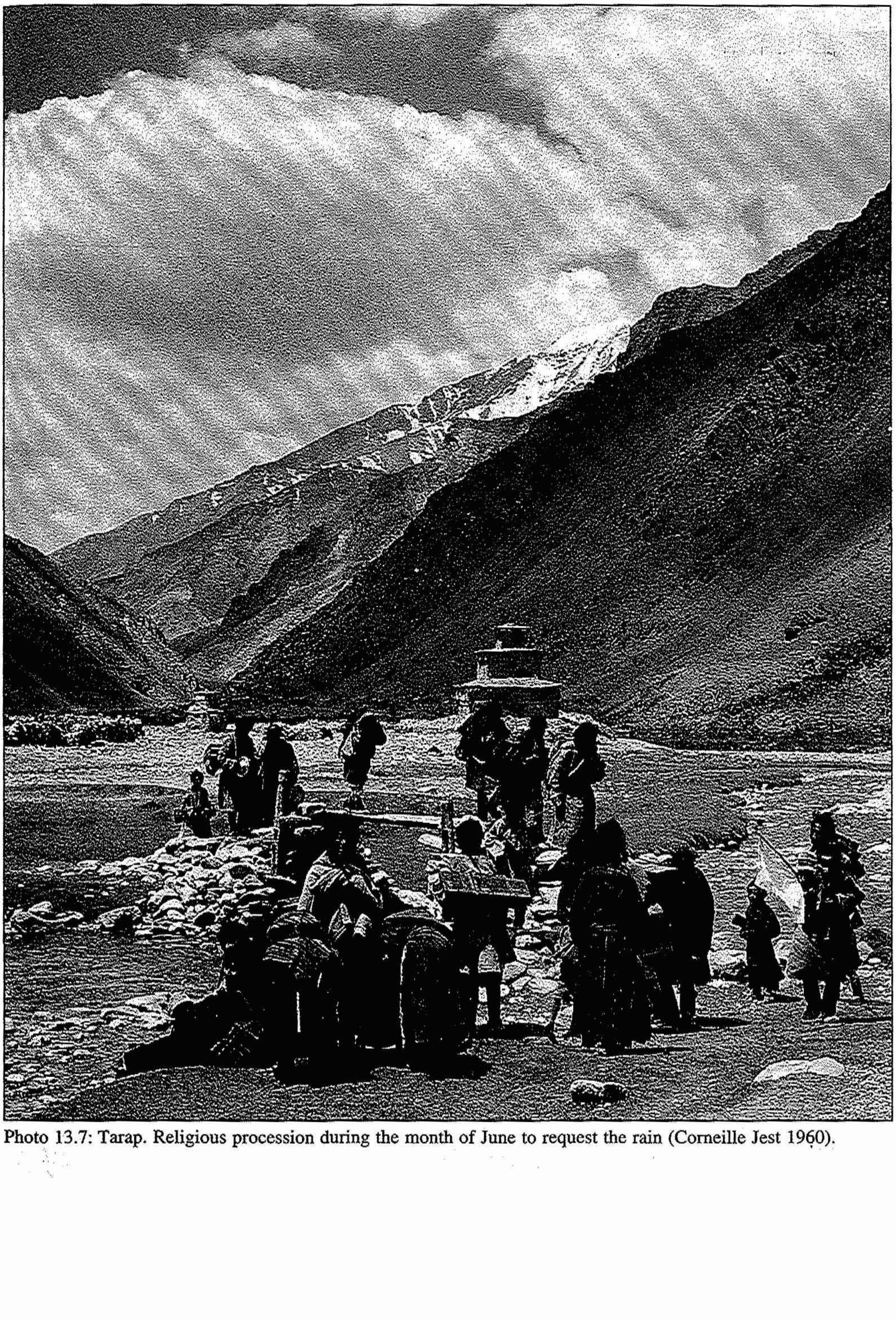

Photo 13.7: Tarap. Religious procession during the month of June to request the rain (Corneille Jest 1960).

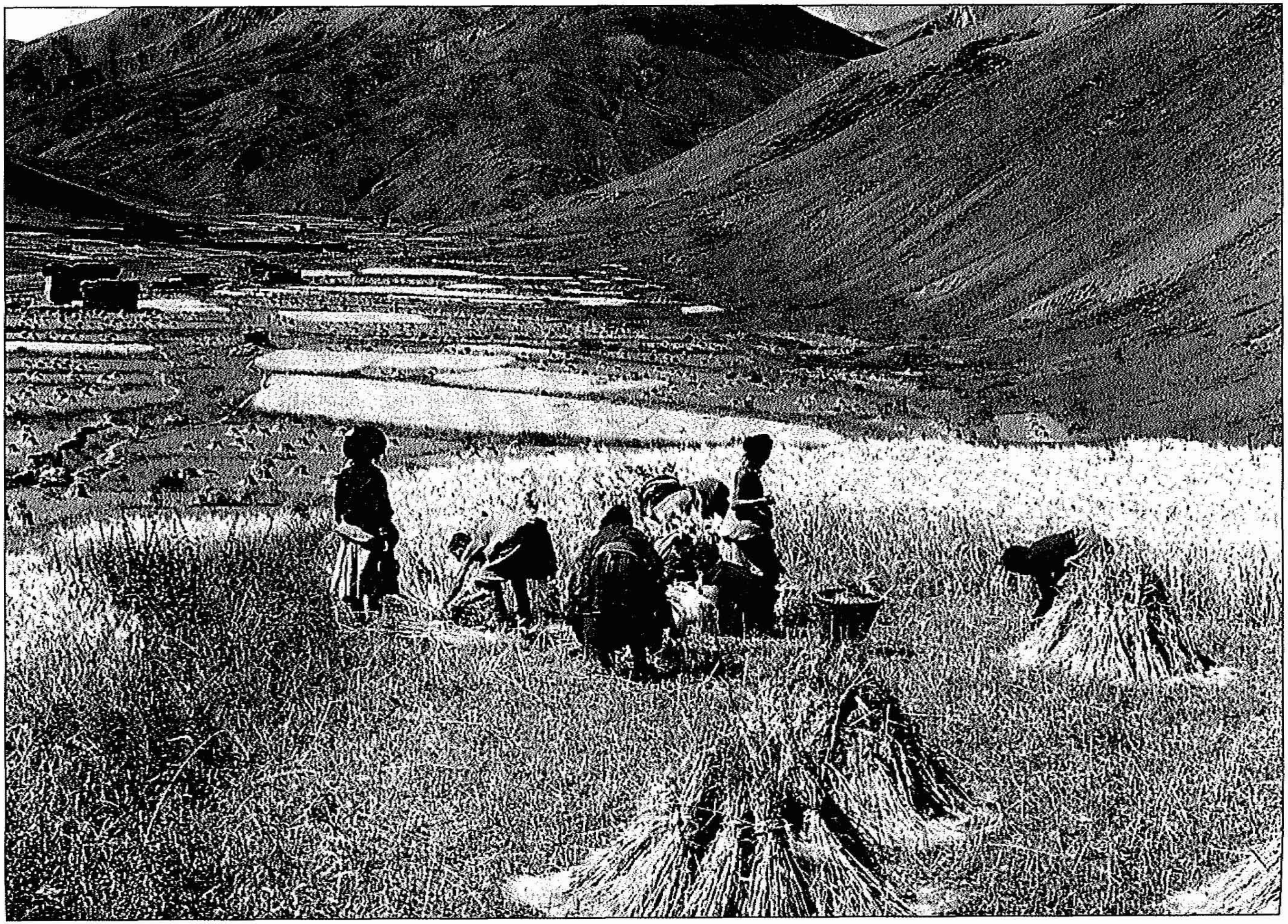

Photo 13.8: Tarap. Harvest of barley, sheaves in the area of Shing-gong in Do (Corneille Jest 1960).

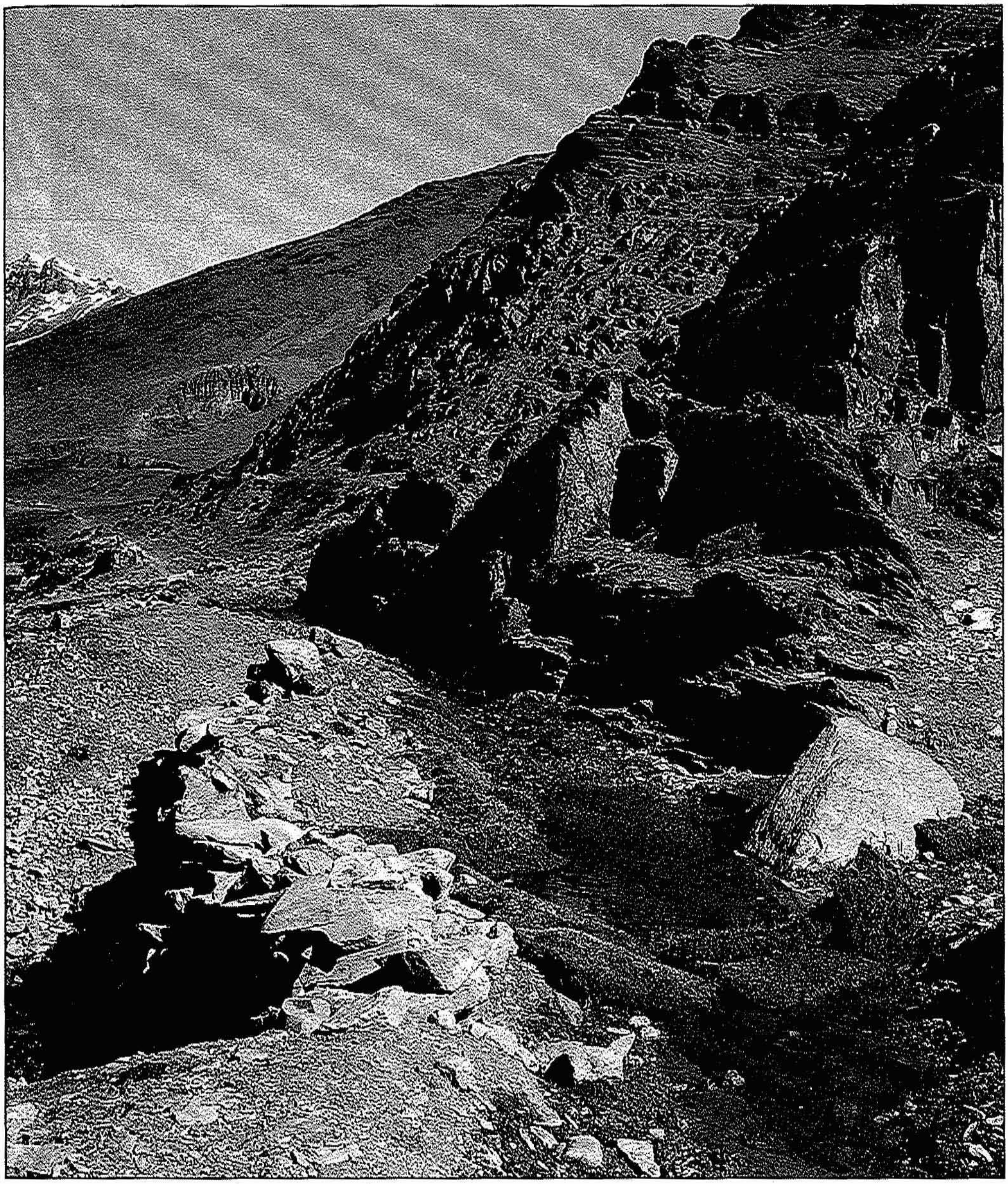

Photo 13.9: Taräp. The Kagar-Og/Dowa yura canal, above Ramso Tö, first diversion of the main canal (Corneille Jest 1960).

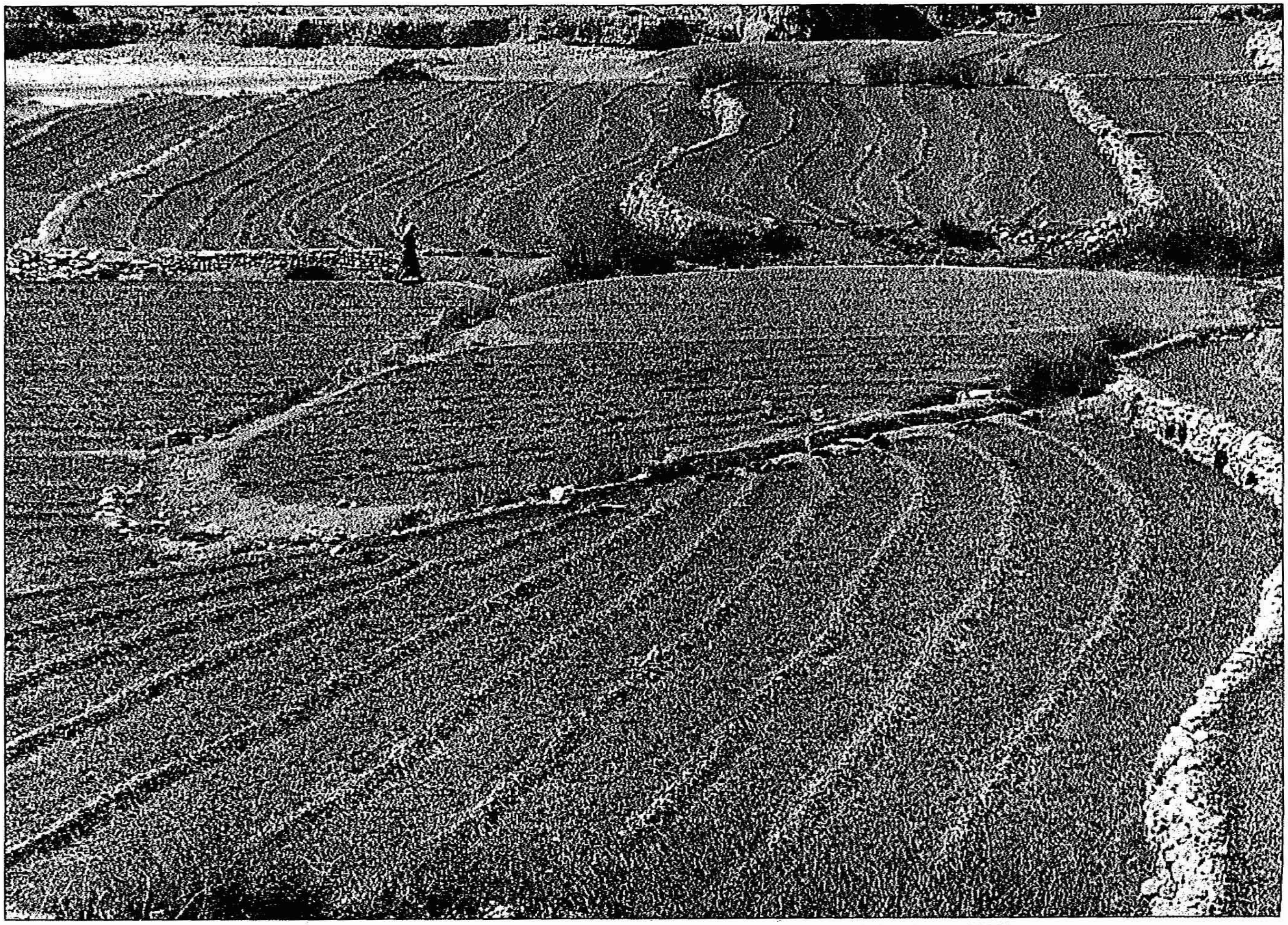

Photo 13.10: Valley of the Kali Gandaki. Thimi, barley fields divided in beds for irrigation purposes (Marc Polge 1993).

To sum up, in Tarap the intake is always located in the river bed of the main stream. The canals have a gradient of one to three percent, and an idle length between one and three kilometres.

THE CULTIVATION OF BARLEY

In Tarap, barley is the unique crop cultivated for environmental reasons mentioned above. The flat profile of the valley bottom allows cultivation with draught animals. On one *möndor* one puts around twenty baskets of manure (thirty kilograms per basket equivalent to twelve tons/hectare). This figure is rather high. Nevertheless, the climatic conditions are such that the composting of the organic components is very slow. The amount of seed sown is expressed in *drubre* (unit used for measurement in volume, equivalent to 1.016 liters), the quantity of seed sown depends on the fertility of the soil.[6]

Agricultural Calendar and Related Activities

The date for starting work is decided by the lama-astrologer. The entire process of cultivation depends on the worship of the deities protecting the soil. No work can be done without consulting the astrologer who determines the auspicious time, *gza-dkar*. Before starting work, a series of rituals, *lha-gsol*, are performed by the lama for the protection of the crop.

A number of tasks have to be carried out as part of field preparation for barley cultivation:

1. **Ploughing after harvest (ninth month).**
   If time and weather permits, a rough ploughing, *log-ma* is done after the harvest and follows a precise pattern to smooth the soil (Fig. 13.5). By doing this, the roots of the weeds are destroyed and extracted. Such ploughing can also be done in early spring before the sowing begins.

2. **Maintenance work on the canal. (second and third month).**
   The village assembly meets to decide on what work has to be undertaken to repair the canal, often partly damaged by the winter snowfalls and rock slides. If there is still ice in the canal, ashes are spread to accelerate the melting process. Each household participates with labour in proportion to the size of the area cultivated.

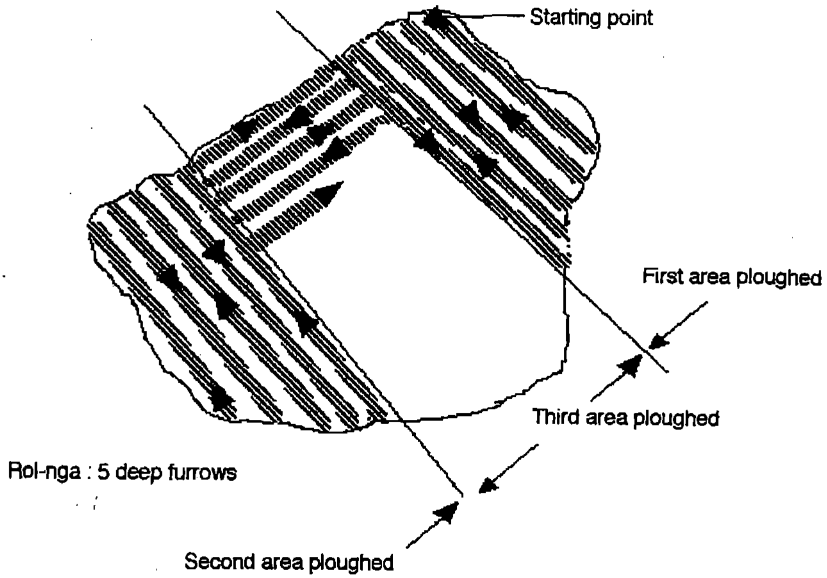

Figure 13.5: Sketch of a winter ploughing.

3. **Cleaning of the fields (third month).**
   Stones are eliminated and the walls which prevent cattle from grazing the fields are repaired.

4. **Transport of manure, lu-tön.**
   Animal and human manure is transported using baskets and put in big heaps in a corner of the field. Each field receives a given number of baskets equivalent to the surface of the field.

5. **Irrigation to moisten the soil before sowing (third month, fifth to tenth day), chu-trü.**
   The water, *gya-chu,* arriving through the canal is guided and spread across the field with the help of hoes and rakes, when possible, water is allowed to flow for one or two days[7].

6. **Scattering of the manure in the field, lü-tor.**
   The manure is put in baskets then poured in small heaps in the field and finally spread all around with a wooden shovel.

7. **Sowing, sabön-tor.**
   The barley is sown. The quantity of grain is prepared in advance so that the sower is aware of the amount of seed available for a given field.

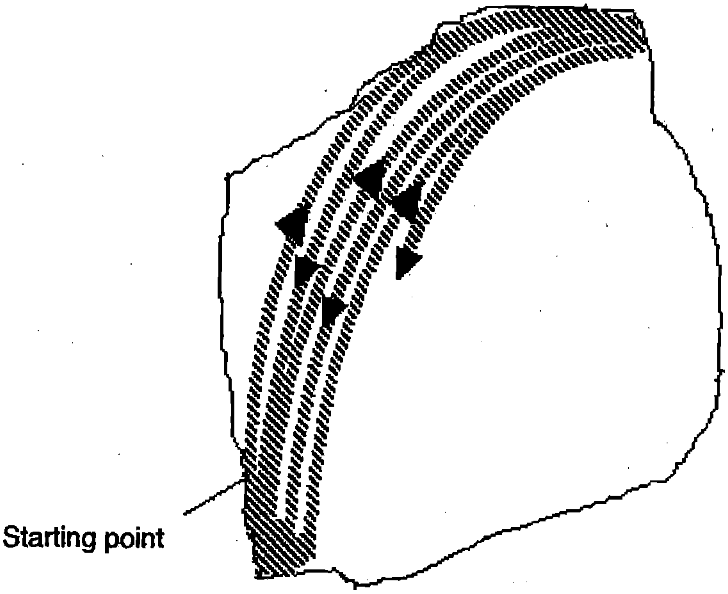

Figure 13.6: Sketch of the ploughing process for covering the seeds.

8. **Ploughing, mö-gyab.**
   Ploughing follows; the furrows are made as long as possible in a diagonal across the field, so one avoids working with a hoe (see Fig. 13.6). Ploughing is done with an ard pulled by two yaks.

9. **Harrowing tre-she.**
   Ploughing is followed by harrowing with a wooden harrow pulled by two yaks.

10. **Preparation of field channels.**
    A group of women use a rake to prepare a field channel, *nyar-tang,* along the upper part of the field's perimeter. (Fig. 13.9). A series of small ten centimetre high bunds, *nang*, are traced with a plough radiating from the *nyar-tang*. These *nang* serve to distribute the water evenly during the next phases of the irrigation process. Water flows down the slope between the bunds.

The cultivation of barley can be subdivided into several different phases:

First weeding, ko-yür or yürma yür (fourth month, tenth day)
The first weeding occurs twenty days after sowing. The work is done by women and requires close attention. Once weeding is completed, the field channels, *nang,* are dug out with a hoe and water, *dong-chu,* is diverted to

the field and distributed according to a specific pattern. The plant is then ten centimetres high.

Second weeding, jango-yür (sixth month)
The second weeding is done during the sixth month when ears appear on the stalk. Irrigation follows, *trog-chu,* "water that gives strength to the plant".

Irrigation during the seventh month, mig-chu.
If it does not rain, the crop is irrigated during the seventh month, *mig-chu.* (same pattern as with the *dong-chu*).

The harvest (eighth month).
Harvesting of the crop begins in the eighth month. As the local proverb says: "When the *Riki Karma* stars[8] appear in the sky, it is time to harvest barley". The crop is cut with a sickle and left to dry in sheaves in the field for a week, so that "the ears get strength". They are then transported to the threshing ground. The straw is stored and given to the cows and yaks as fodder in winter.

The Yield

According to farmers, the barley yields are not very high. For one measure of grain sown, one can harvest between two and six measures. If we assume that one *drubre* (0.920 kilograms of naked barley) is sown on thirty-four square metres[9], the yield would be five to sixteen quintals per hectare. This is rather better than the district profile figures given by the government, but one should use these estimates with care.

Comments on the Irrigation Pattern

The soil is rich in coarse elements so that water holding capacity may be rather low; there are only four irrigations during the four month crop cultivation period. An estimate of the Penman Potential Evapo-transpiration (PET) for Dolpo shows that the maximum demand is in May and June, with a mean daily PET value of about 3 to 3.3 millimetres (Fig. 13.2 and Annex 2). Since the PET values are only estimates, no detailed conclusion can be drawn from the figures. However, it is surprising that the longest interval between irrigation—four to six weeks—occurs during the period of highest climatological demand (80 to 100 millimetres of water needed for barley between the end of May and mid-July). Moreover, the farmers gave no impression of any water deficit during that period (conflicts are not usual during these weeks!). If this impression is confirmed two hypotheses might account for the behaviour:

- The water holding capacity is greater than it has appeared to be,
- some degree of water stress is tolerated before the barley forms an ear; These facts show that this approach to water management needs further clarification and study before any conclusions can be reached.

Sharing of Water Resources

A village assembly manages the water resources of the valley and regular meetings help to solve technical problems as well as to settle disputes. Water rights are known by all. There is sufficient water in Tok-kyu, so that management is easy compared to Do, where there is some water scarcity. This shortage inspired an original way of sharing water through the drawing of lots, under the supervision of the village assembly.

Another example of the role of the village assembly comes from Rubdi, which was, a long time ago, a village and a fortress, *dzong*. Local tradition mentions that there was an epidemic at that site, after which the inhabitants abandoned the place, continuing to use it only as a summer pasture. In 1955, a lama from the Tibetan province of Kham who lived in Tarap asked the head of the village permission to cultivate land there, together with another person who was a newcomer. The village assembly gave them permission to cultivate the abandoned fields of Rubdi. A religious ceremony was performed to expel the demons and evil spirits. Soon after the villagers of Do and Doro also began to renovate the canals of the village (Numbers 12 and 13) and to cultivate some of its land. The Tsoglung-chu reserved priority for use of the water from the Doro-og canal (Number 14) which belonged to the inhabitants of Doro, as the Rubdi canals (Numbers 12 and 13) were now considered "new canals".

Social Organization of Labour

As the different activities must be carried out within a very short period of time, farmers are obliged to organize themselves into a tight time schedule. All farmers form themselves into labour teams or groups of "share-holders", which take into account each farmer's manpower resources, draught animals (pairs of yaks) and equipment. Team work, *lag-deb,* in which each household contributes in labour, draught animals and tools ensures that resources are efficiently used. Agreement is reached through community meetings, *mi-dzom.*

Everyone is also conscious that the watering period, if not properly worked out and strictly followed, can harm the ripening of the crop. Deficiency of water requires a high degree of social organization and co-operation, thus a schedule of irrigation is planned. It is also important to work rapidly, in the shortest time possible, so that the timing of each phase of the cultivation calendar is respected during the short cultivation cycle.

In Tok-Kyu, there are four labour groups, *lag-deb*, which plough the area from upstream to downstream, in succession, according to an age-old tradition. The work begins in Khangchung, then Mondro, Chumaga, Kagar, Trangmar, and Raytega. It is the same for Do and Lang. In addition, households belonging to religious lineages have priority to the water.

WATER MANAGEMENT AT THE CANAL LEVEL

The first command area of the Kagar og/Dowa canal (Number 10) known as Ramso Tö is presented, in detail, as a model for the area's approach to irrigation, with an analysis to follow.

Command Areas of the Canal

The water of the Kagar Og canal is distributed to three areas: Ramso Tö (upper Ramso) and Ramso Og (lower Ramso) in Tok-Kyu and Tsi Gong in Do (Fig. 13.7). As the canal was built by the inhabitants of Do, they have priority for the utilization of water. Thus:

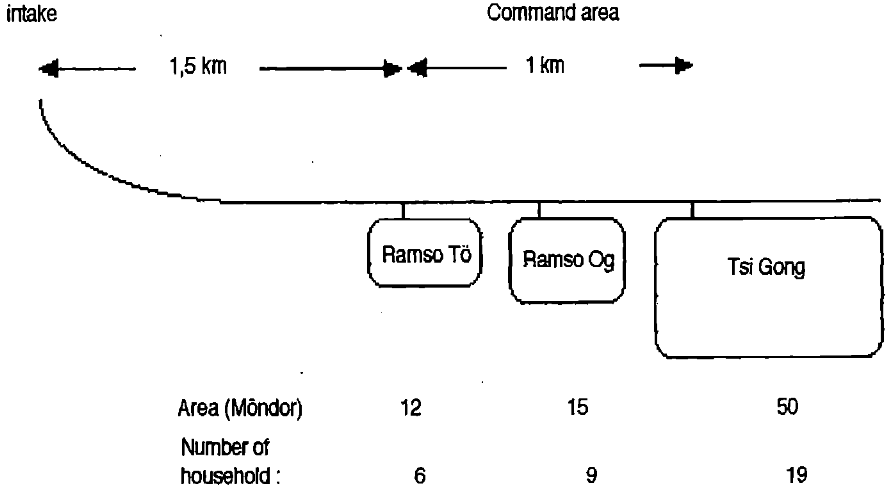

Figure 13.7: The Kagar-Og/Dowa canal and command area.

first irrigation *gya-chu*, irrigation to moisten the soil,

Do Tsi-Gong	seven days
Ramso Tö	one day
Ramso Og	one day

second irrigation, first weeding, *dong-chu*

Do Tsi-Gong	fourteen days
Ramso Tö	six days
Ramso Og	six days

third irrigation, second weeding, *trog-chu*

Do Tsi-Gong	fourteen days
Ramso Tö	six days
Ramso Og	six days

fourth irrigation, if necessary (when no rain), *mig-chu*

Do Tsi-Gong	fourteen days
Ramso Tö	six days
Ramso Og	six days

Water Management within the Command Area of Ramso Tö: History and Plan of Ramso Tö

The command area of Ramso Tö was studied in some detail. It is located on the territory of Tok-Kyu, close to Do on a terrace above the Tarap-Chu on its left bank. It lies at an altitude of 4225 metres. The area is dominated by steep slopes.

According to oral tradition, there were originally four houses in the valley of Tarap: Rabga, Londge, Rubdi and Ramso. All four households were abandoned long ago. At the beginning of this century, the fields were again planted by the lineage of Trangmar (Tok-Kyu) which used the existing canal Kagar Og, carrying water to Do, to irrigate some fields. This is why Ramso Tö gets water after Do. A new section of this canal was dug, at a higher contour level, just above Ramso in 1983. In this way, the irrigated area was extended between the old and the new sections, the old section of the canal being transformed into a branch canal (Fig. 13.8).

Among the ten diversions, *kha*, which distribute water to the command area, seven get water from the main canal through the branch (old main canal) from upstream; the diversions eight and nine get water from the main canal (*yura Sarwa*) through the branch (old main canal, *yura ningba*) where the slope has been reversed (Fig. 13.8).

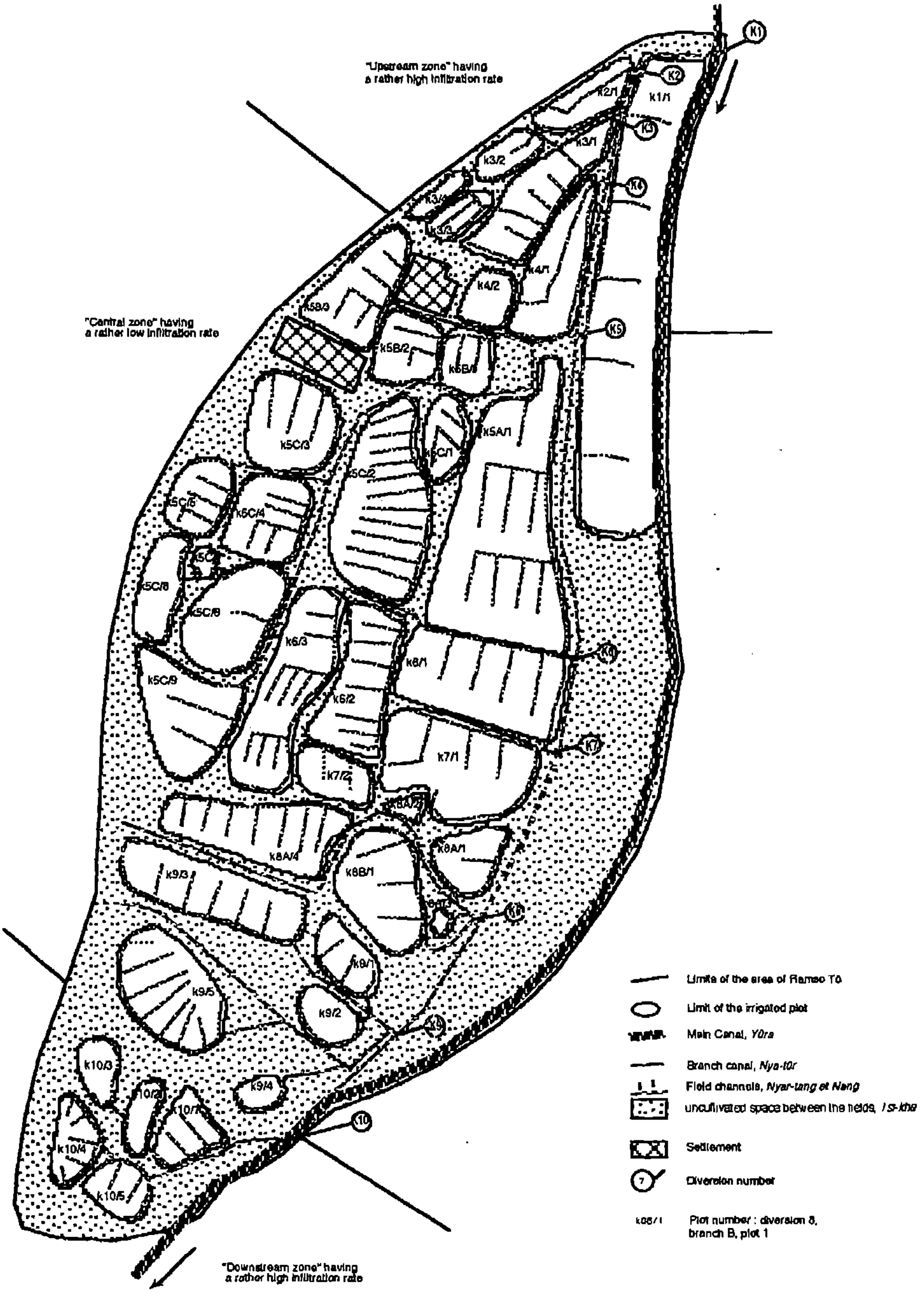

Figure 13.8: Schematic plan of the command area of Ramso-Tö.

In 1993, the fields of Ramso Tö had a total area of 12 *möndor,* owned by 8 households (Tab. 13.2 and 13.3), *thaka,* but actually considered as an area of 4 *thaka.*

Tab. 13.2
List of the owners and the area owned

Owner	Measures of Seed
Chogpa	80
Kunga	23
Kungya	197.5
U. Nyima	23
T. Puti	15
Tarwo	15
C. Tsering	11
Ngawang	31
TOTAL	395.5

Tab. 13.3
List of the field owners of Ramso Tö

Number of field	Name of field	Name of household	Measures sown	Number of *Nang*
K1-1	Köpo Samba[a]	Chogpa	20	5
K2-1*	Kunga'i Shing	Kunga	8	2
K3-1	Kunga'i Shing	Kunga	15	7
K3-2	Tragtse	Nyima	5	2
K3-3	Tragtse Hê	Kungya	4	0
K3-4	Tragtse	Kungya	5	2
K4-1	Shing-Ringmo	Kungya	12	12
K4-2	Tragtse Kir Kir	Kungya	1	0
K5-A1	Ringmo	Chogpa	25	15
K5-B1	Yulsa Gyab	Kungya	7	3
K5-B2	Yulsa	Kungya	10	3
K5-B3	Yulsa Og	Kungya	8	
K5-C1	Tragtse	Kungya	7	4
K5-C2	Trubying	Kungya	25	11
K5-C3	Khanggyab	Kungya	15	4
K5-C4	'Shingka'	Kungya	11	6
K5-C5	Shing Nar Nar	Kungya	12	4
K5-C6	'Nang-Gni'	Kungya	5	2
K5-C7	Tragtse	Kungya	0.5	
K5-C8	Tragtse Chung	Kungya	1	
K5-C9	Zur-Sum	Kungya	10	3
K6-1	'Puti Gi Shing	T. Puti	15	6
K6-2	Nyima'i Shing	Nyima	18	7

K6-3	Tsig-je	Kungya	27	14
K7-1	Ringmo[b]	Chogpa		4
K7-2	Ködrug	Kungya	7	3
K8 water arrives from *yura sarwa* and comes back 'upstream' through *yura ningba*				
K8-A1	Zur Sum	Chogpa	5	2
K8-A2	Tragtse Chung Chung	Chogpa	1.5	0
K8-A3	Tragtse	Chogpa	0.5	0
K8-A4	Kopo	Kungya	23	8
K8-B1	K. Tarwo Shing	Tarwo	15	4
K9 As for K8 water comes from *yura sarwa* 'upstream' in *yura ningba*				
K9-1	Shingka	Kungya	7	3
K9-2	Tragtse	Chogpa	2	0
K9-3	Champa Tsering	C. Tsering	11	6
K9-4	Tragtse	Chogpa	3	0
K9-5	Kung-Chung Shing	Chogpa	23	12
K10 this diversion is directly done from *yura sarwa*				
K10-1	Champa Ngawang	Ngawang	5	4
K10-2	Tragtse	Ngawang	2	0
K10-3	Tragtse	Ngawang	4	0
K10-4	Shingka	Ngawang	13	7
K10-5	Shingka	Ngawang	7	3

[a] created five years ago

[b] joined with K5-A1

*The first irrigation of plots K1, 2, 3, 4 and 10 takes place at dawn of the second day, because the water holding capacity of the soil of these plots is low.

Most of the present owners of Ramso belong to the Trangmar lineage. Lama Randrol divided his property between his two sons. The present distribution is shown in Fig. 13. 9 and 13.10.

Irrigation to Soak the Command Area of Ramso-Tö

Soaking irrigation allows soil to be easily tilled and provides the moisture necessary for the germination of grain. As the soil has a propensity for rapidly drying out, sowing and ploughing are carried out as close to each other as possible. Thus on the day when water is allocated to Ramso Tö, the organization of labour would depend upon:

- the quantity of water available,
- the water holding capacity of the soil in the field,
- the availability of manpower and draught animals to do the work.

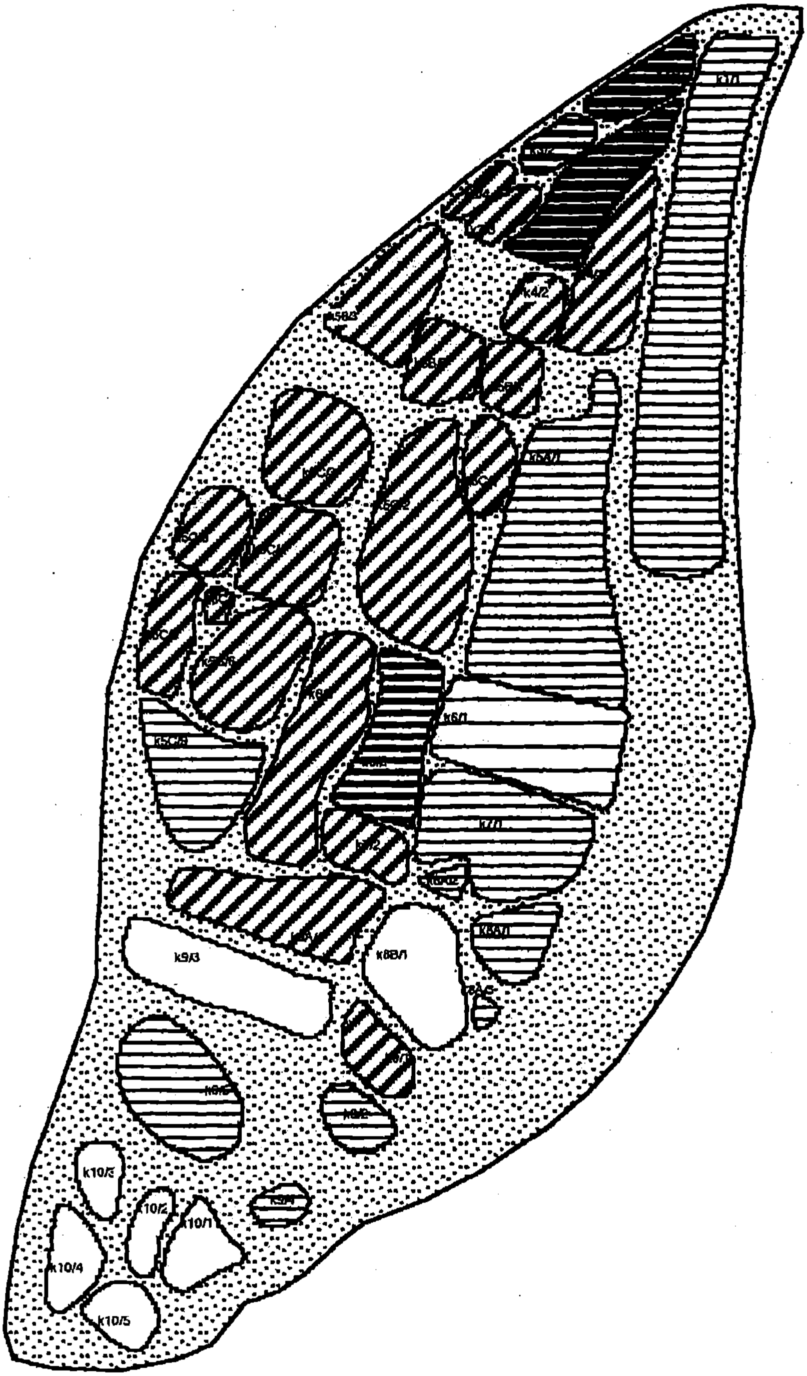

Figure 13.9: Ownership of the fields of Ramso-Tö.

The farmer's experience has led them to divide Ramso-Tö into two distinct areas classified according to the nature of their soil: a central zone with a rather low infiltration rate which holds moisture, and an upstream-downstream external zone with a higher percentage of sand which dries out rapidly (Fig. 13.8). The water resources allow that the first irrigation can last for more than a full day. During the first day, the central zone is irrigated. The next day, at dawn, the two external zones (diversions 1, 2, 3, 4 and 10) are irrigated, sowing and ploughing to cover the seeds immediately following irrigation. Distribution of water is done for each diversion from the upper field to the lower field along the branch canals. The flow of water to each field is controlled and guided with hoes and rakes.

In the case of the K5 diversion, the water seems sufficient to be divided into two or three shares, *chu-khang,* without any distribution box. The three *chu-kang* provide water simultaneously to the field channels 5A, 5B, 5C. We did not notice special forms of distribution in the other diversions.

Successive Irrigation

The distribution of water across a field for soaking irrigation is done with hoes and rakes. For other irrigation, a precise water distribution pattern is followed. The *nya-yür,* or secondary canal, brings water to a number of fields. Water runs down into a *nyar-tang* and then to the successive *nang.* The mean width of a *nang* is 20–25 centimetres and its mean depth is 15 centimetres. The space between two *nang* varies between four and six metres. Irrigation of a field, is carried out in small patches from a field channel, *og-kha,* opened from the *nang* (Fig. 13.11).

After the first weeding, irrigation is carried out by directing the water first to the lower part of the field and then upstream through the system (from *og kha* Number 1 to Number 25, see Fig. 13.11). After the second weeding, irrigation is carried out from the upper part of the field downwards (from *og-kha* Number 25 to Number 1). If there is a third irrigation, it would follow the pattern of the first weeding.

Alternative Solutions Observed in Other Irrigation Systems. Determination of the Order of Water Allocation by Drawing Lots

We have noted that in Ramso Tö, the soaking irrigation is carried out over a short period of time and the fields of a single owner are close together and closely related to the orientation of the field canals. There, the order of water distribution is largely determined by strict technical criteria.

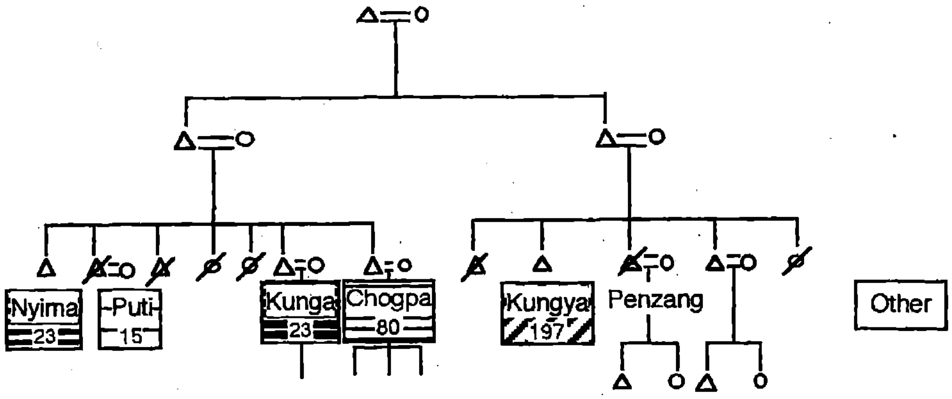

Figure 13.10: Genealogy of the Trangmar lineage.

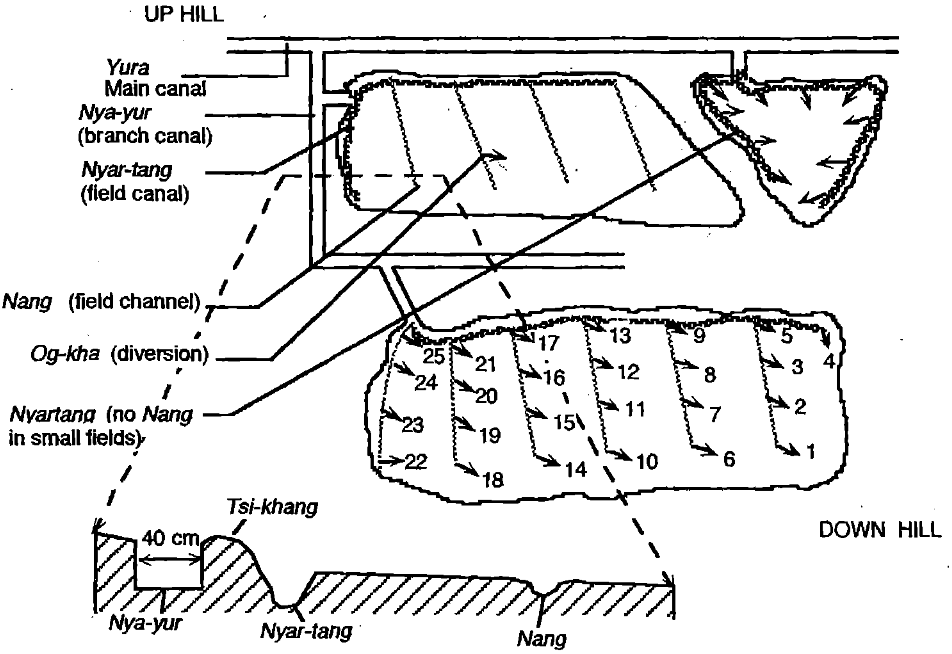

Figure 13.11: Sketch of field and water distribution patterns.

In Do, in the Tsi-Gong area, the irrigation processes for soaking the soil and watering the plants lasts between seven and fourteen days. For this reason, there is competition between owners to benefit from the first turn. It was admitted that the water is only sufficient to irrigate two households, *thaka*, in one day. Before starting the cultivation period, the owners meet and determine the order in which water will be distributed. This will ipso-facto organize the different phases of work in the field, sowing, ploughing and so on as well as the mutual aid.

To draw lots, each farmer chooses an object and an outside person will designate the order of distribution. This method presupposes that all households have the same land holding area, which is not the case. For this reason, an adjustment is made and in one day a single large household, or two or more smaller ones are supplied with water. In a case of two or more owners having to share the water during a single day, the time length of each share is determined by estimating the position of the sun, using a simple sun dial made with a stick.

One may ask whether the solution of drawing lots is, in certain cases, a way of avoiding distributing water to big landowners at the beginning of the rotation or because of the long duration of each phase of water distribution.

Using "beds" as an Alternative to Field Channels, *nang*

Farmers distribute water through a network of *nyar-tang* and *nang* in all the fields of Tarap. In the valleys of Panzang situated to the north of Tarap, as well as in the valley of the Kali Gandaki (Pelag, Dangarzong, Kagbeni, Thimi etc.), however, fields are divided into "beds" using small bunds, *long*, (Valleix 1974 and personal observation M.P.C.). The width of such a bed is about three meters (Fig. 13.12). Each bed is watered through an opening on the *nyar-tang*. It seems that the use of this technique is adapted to soil which has a low infiltration rate, where otherwise seepage at the head of the bed would be too high.

Overview of the Various Irrigation Systems of Dolpo

In Dolpo, in most of the settlements, water is scarce and lots are drawn to determine the order of rotation. There is no reserve of water in the form of névé and water must be stored in reservoirs during the night. The order of distribution is determined at dawn and follows a precise rotation. It is a tradition that the older households of the upper social strata get the first water shares. (Tab. 13.4). One can see abandoned terraces and human settlements in most of the valleys of Dolpo. This is often explained by the scarcity of water and the drying up of water sources.

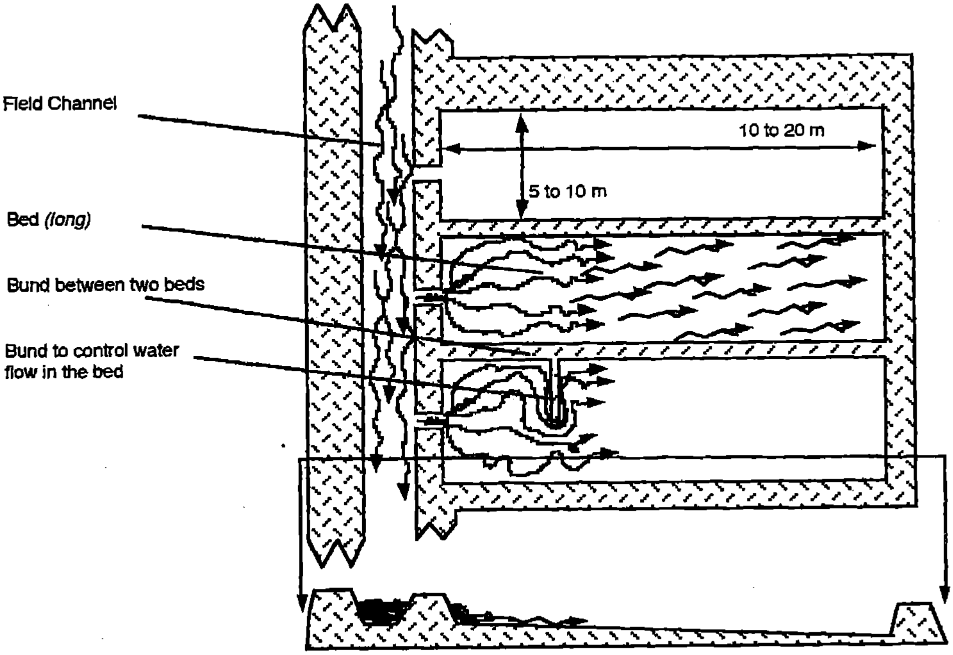

Figure 13.12: Sketch of a field divided in beds and water distribution pattern.

Tab. 13.4
Technical characteristics of irrigation systems in Dolpo

	Scarcity of water	Drawing lots	Reservoirs
Tarap			
Tok-kyu	No		
Do	Yes	Yes	
Charkha	Yes		
Barbung	Yes		
Panzang	Yes		
Ting-kyu	No		
Polde	No		
Shimen	Yes	Yes	
Namgung	Yes		
Saldang	Yes	Yes	several small reservoirs
Karang	Yes		17 small reservoirs
Koma	Yes		2 reservoirs
Lhori	Yes		1 reservoir
Phijor	Yes		reservoir

CONCLUSIONS

In the above, we have presented a discussion of the water management system in a steppic zone in the central Himalayas. Irrigation, which is dependent on the fortunes of winter precipitation, is also necessary to the local agricultural practice, the basic component of the life of the population. Factors such as the gradient and volume of water permit good irrigation scheduling in Dolpo. The infiltration rate of the soil, soil depth and water requirements are problems and the farmers use two types of application to solve them: wild flooding at the first stage, followed by a flooding along borders of furrows in the second. Through empirical experience, the farmers of Tarap have developed a sensible compromise that would most likely correspond with recommendations from any outside experts.

From field observation in areas above 4000 metres, where barley is the only cultivated cereal, water is only needed for three or four short periods during the cropping cycle between April and August. At a lower altitude, less than 4000 metres, crops vary and water is needed permanently. Summer is a period of intense activity for all members of the community with summer pastoralism being carried out at high altitude as well as agricultural activities. Sometimes, limitations of manpower and draught animals are more important factors than constraints of water supply. It can be concluded, however, that physical improvements such as improved maintenance with appropriate tools and extension of the command area are necessary to improve the reliability of the water supply.

Since 1985, the Government of Nepal has given some financial support for canal maintenance in Dolpo district, but no improvements were made due to a lack of technical advice and the unwillingness of local farmers to do more than the minimum needed to ensure their basic water needs. It must be noted that all of the reasonable irrigation canals have already been constructed. If new ones were to be built, they would be more difficult and very expensive; way beyond the means of the villagers to construct by themselves.

Annex 1. Glossary of terms related to water management

The Tibetan technical terms which follow are in phonetic spelling. Transliteration according to the Wyllie system appears in brackets.

Tibetan technical term	English translation
chu (chu)	water, by extension, irrigation water
chu-go (chu-mgo)	source of streams, rivers
chu-gyen (chu-rgyan)	to draw lots
chu-gyen chig	first beneficiary of a water share

chu-gyen gni	second beneficiary of a water share
chu-gyen sum	third beneficiary of a water share
chu-kha (chu-kha)	intake of secondary canal
chu-kor (chu-skor)	water mill
chu-khang (chu-khang)	a share of water
chu-kyil gi dug	overflow of water
chu-log	overflow after heavy rain
chu-phü	the share of water given first to the headman, a lama or founder of the irrigation canal
chu-trü	irrigation
dong-chu	irrigation after first weeding ('the leaf of barley has the shape of an arrow')
gya-chu	first irrigation after ploughing/stream
mig-chu (mig-chu)	irrigation if there is no rain
trog-chu	irrigation after second weeding ('stalk without ear')
dru-bre	a measure of volume equivalent to 1,016 liter and 920 grams of naked barley.
dzing (rdzing)	reservoir
dja ('dza)	parallel nang 'in form of a rainbow'
kha (kha)	diversion (lit. 'mouth', 'opening')
og-kha	small derivation or a nang
ko (rko)	to dig, to hoe
ko-ma (rko-ma)	tool used for weeding
Lag-theb (lag-rteb)	group of workers; team
log (slog)	to turn the earth upside down
sö-log (sos-slog)	spring ploughing to soften the soil, third month
tön-log (ston-slog)	autumn ploughing, eighth to ninth month
log-gyab	ploughing to loosen the soil
log-ma	ploughing to loosen the soil
long (lon)	bund, by extension bed
lü (lud)	manure
lü-ton (lud'don)	extraction and transport of manure
lü-tor	spreading of manure in the field
mö-gyab (rmon-rgyab)	ploughing to cover the seeds
mö-pa (rmon-pa)	to plough
möndor (rmon-dor)	pair of plough yaks/area ploughed by a pair of yak in one day, equivalent to 0.05 hectare
nang (nang)	field channel
nyar-tang	field canal
pong	turf
rol-nga (rol lnga)	'five furrows'
sa	earth
sa dur dur	very soft earth which does not hold together
sa kyong-po	coarse earth, very permeable
sa log	to plough up, turn up
sabön tor (sa-bon gtor)	sowing
sa pesa	sandy soil
sha	area of waterlogging/swamp
shingkha	field
shing le tang sum	the three important moments for irrigation
thaka	household

tre	harrow
tre-she	harrowing
tsi-khang	space between two fields, not cultivated
tur (gud)	bed slope
yürma (yur-ma)	the act of weeding
ko-yür (rko-yur)	first weeding with the koma
jango-yür (ljang-yur)	second weeding
yül-ra	enclosed space near a house to keep cattle
yüra (yur-ba)	irrigation canal
yür-go	diversion structure/dam intake or beginning of canal
yür-kha	intake
gya-yür	main canal
nya-yür	branch canal/secondary canal

Annex 2. Reconstitution of Climatological Data for Tarap on the Base of the Lo-Mantang Data (Mustang 3705 m)

The average precipitation was calculated with data from Lo-Mantang between 1974 and 1990. The average temperatures were calculated with data from 1974 to 1986: the basic data are the monthly average of the daily temperature 1/2(Tmin + Tmax). The result is then corrected according to altitude, assuming that temperature in Dolpo is 1.7 °C less than in Lo-Mantang (1 °C less per 100 metres higher). The wind, sunshine and humidity data used for PET estimation come from Lo-Mantang station in 1984

Tab. 13.5
Adjusted climatic data for Tarap, Dolpo

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average monthly precipitation (mm)	7,9	7,6	4,2	2,5	3,4	7,8	50,4	46,6	13,3	11,4	2,1	7,2
Average monthly daily temperature (C)	-5,7	-4,4	0,1	4,1	7,5	11,2	12,2	12,1	9,6	4,9	0,7	-1,3
Estimated PET (mm)	2	9	34	63	92	94	81	74	52	25	1	3
Wind (m/s) 1984	1,3	2,4	1,6	1,7	1,7	1,8	1,6	1,3	1,4	1,5	1,3	1,8
Humidity (%) 1984	95	95	86	77	88	86	89	94	94	87,5	97	95
Sunshine (hours/day) 1984	8	7,9	8,8	8,2	9,5	7,3	5,2	6,6	8,1	7,9	7,8	7,9

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Maps

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NOTES

*The results presented in this study are based on fieldwork done in 1994.

1. The origin and development of the irrigation systems in steppic areas will not be discussed in this paper. Instead, it is pointed out the system described is identical to those observed in other steppic valleys of the Himalayas and in the Tibetan Autonomous Region of China (Hummel 1958, Zhang Rongzu 1989).
2. The Dolpo District has a total area of 7890 square kilometres: the northern part of the district is called the "Bhot region" and is comprise of six Village Development Committees (former-Panchayats) of Mukot, Charka, Do, Tinje, Phijor, Saldang, with a total population of 5300 inhabitants comprising 865 households. Barley, the only cereal cultivated, has a productivity of three to six quintals per hectare. Livestock rearing forms an integral part of the Dolpo farming system: 14,000 sheep, 6175 yaks and crossbreeds of yak and bovines and 615 horses. These figures cannot be considered accurate: Source: *District profile Dolpo* 1988, established by the District Panchayat Secretary.
3. Six-rowed naked barley is the grain cultivated in high altitude regions. This variety of barley is adapted to a very short growing season.
4. Analysis of soil samples indicate that the clay ratio is low (9 to 14 per cent), the loam ratio is 18 to 30 per cent with a high sand ratio (30 to 60 per cent), INRA 1962. Note that no measurements for water holding capacity have ever been made in the area.
5. In former times, there were no water mills in the valley of Tarap due to religious beliefs. Five generations ago a villager built a water mill but soon after men and cattle died in great numbers. It was then decided not to use a water mill in the valley anymore.

6.

in Do	1 *möndor*	receives	50	measures (*dru-bre* of seeds)		
in Rubdi	"	"	60	"	with a yield of 200 *dru-bre*	
in Shibchog	"	"	30	"	200	"
in Doro	"	"	30	"	70	"

An area of 30 *möndor* requires ten days for ploughing and sowing.

7. *gya-chu* : *gya* means white : before irrigation, the earth is whitish in color and the water will eliminate this color.
8. This fixed star *skar-ma rib ci* appears in the sky in September indicating the beginning of autumn in the Tibetan astrological tradition.
9. The area estimate of the two plots of Ramso Tö is:
   - plot K5C/9 : 8 *drubre* sown, 280 m2, so that 1 *drubre* is sown on 35 m2;
   - plot K6/3 : 25 *drubre* sown, 820 m2, so that 1 *drubre* is sown on 33 m2.

14

Natural Conditions and Hazards for Irrigation in the Arid Himalaya of Upper Mustang District, Nepal

Monique Fort

> ...The strange land of Lo (Mustang) with its flat barren, brown hills, deeply cut and eroded, a chaotic and fantastic landscape in complete contrast to the cold majestic summits to the south...(Snellgrove 1961: 165)

INTRODUCTION

Irrigated agriculture is common in arid regions of Central Asia: it primarily relies on water derived from the adjacent high mountains and their snowy or glaciated slopes and peaks. It has given rise to a variety of systems, traditional or modern, developed by different societies in order to control the availability and distribution of water in space and time. Traditional forms of water management, although developed for many centuries, may reach highly sophisticated levels and this frequently is associated with a strong social organization, as can be observed in Hunza (Kreutzmann 1988). In contrast, the Mustang system of irrigation in Nepal appears to be very crude, yet sufficient to satisfy the alimentary needs of a few people (the population density is <0.1 inhabitants per km^2). Not only do the inhabitants have quite extensive cultivated areas at their disposal, but they also have other potential sources of income, based on trading and, more recently, on tourism. In the context of the arid, northern Himalayan areas, however, the Mustang valley is of particular interest. Its exceptionally harsh environment and dissected topography make the geo-ecological conditions of irrigation and the potential natural hazards more severe than anywhere else does.

These require important maintenance efforts that the diverse social groups living in the area have provided so far.

Upper Mustang, located north of Nepal at the border with China (Fig. 14.1), and open to foreigners since October 1992, remains a poorly known area. Early research was chiefly devoted to anthropology (Tucci 1953; Snellgrove 1961; Bista 1967; Peissel 1967; Fürer-Haimendorf 1975), with the exception of the geological reconnaissance of Toni Hagen (1968–69) and Bordet et al. (1971). In spring 1993 and 1994, we briefly visited the upper Mustang district to carry out geomorphological and natural hazards research as a continuation of our previous work in lower Mustang (Fort et al. 1982; Fort 1987, 1993). This article is principally aimed at documenting the specific physical conditions of irrigation and to emphasize the natural hazards that may threaten the irrigation system. This will be preceded by a short presentation of the regional geographical and socio-economic context, whereas the future of the Lo country and its people will be discussed in the conclusion.

THE MUSTANG AREA

The generally termed "Mustang area" is located in the upper part of the Mustang District (Fig. 14.2). It corresponds to the source area of the Kali Gandaki River, one of the longest tributaries of the Ganga, which flows southward through deep gorges (2000-to-1200 m) cutting across the mighty Dhaulagiri (8172 m) and Annapurna (8078 m) Ranges. Most of the Mustang district extends within the rain shadow of the Higher Himalayan Range. Within twenty kilometres, in fact, one passes from subtropical and temperate coniferous forests (1000-to->2000 mm mean average precipitation around Lete) to an alpine, cold and windy desert, where only xerophytic vegetation can develop, except for an intermediate (3700–4200 m in elevation) narrow belt, where an open forest of Juniperus and Betula can still be observed (Dobremez 1975; Miehe 1982). The rugged topography, with deep canyons and ravines, did not, however, prevent the area from becoming the main western trade route from Nepal to Tibet. The upper part of Mustang offers three "low and easy" passes (respectively the Kore La, 4410 m; the Phuphu La, 4205 m; the Chak La, 4200 m): compared to the passes in central and eastern Nepal (Larkya La, Nangpa La), they are flat, and both aridity and strong winds keep them free of snow most of the year.

Three major groups of people have settled along the Kali Gandaki valley: the Thakhali (Thaksatsae and Panchgaon), part of an ethnic group which also includes such tribes as Tamang and Gurung, and the peoples of Baragaon and Lo, both of Bhotia origin and culturally close to Tibetans. The Thakhali occupy lower Mustang (2200–2700 m), and they live in

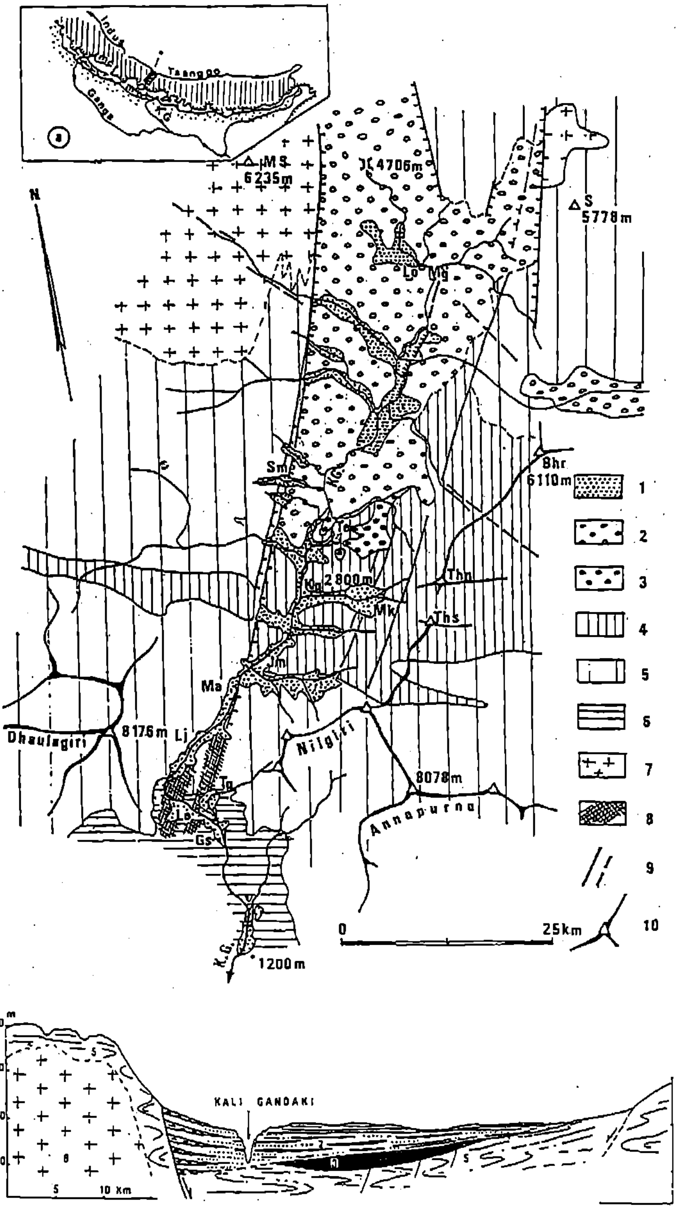


Figure 14.1: The Mustang area: location (Fig. 14.1a), geological setting (Fig. 14.1b) and geological cross-section (Fig. 14.1c). The basin is a tectonic depression delimited to the west by a steep, mountain flank, corresponding to an upthrown, faulted "horst". A sharp contrast exists between the slopes of the horst, where granites (7) to the northwest and predominantly dark shales and schists (4 and 5) are outcropping, and the graben itself, filled by 1000 m-thick sediments (2 and 3) eroded from the western horst. The "graben" filling has been dissected into steep cliffs by the Kali Gandaki river and its affluents. The recent gravelly terraces (1) entrenched within the former deposits provide suitable sites for villages. Key numbers in bracket refer to as symbols on the map.

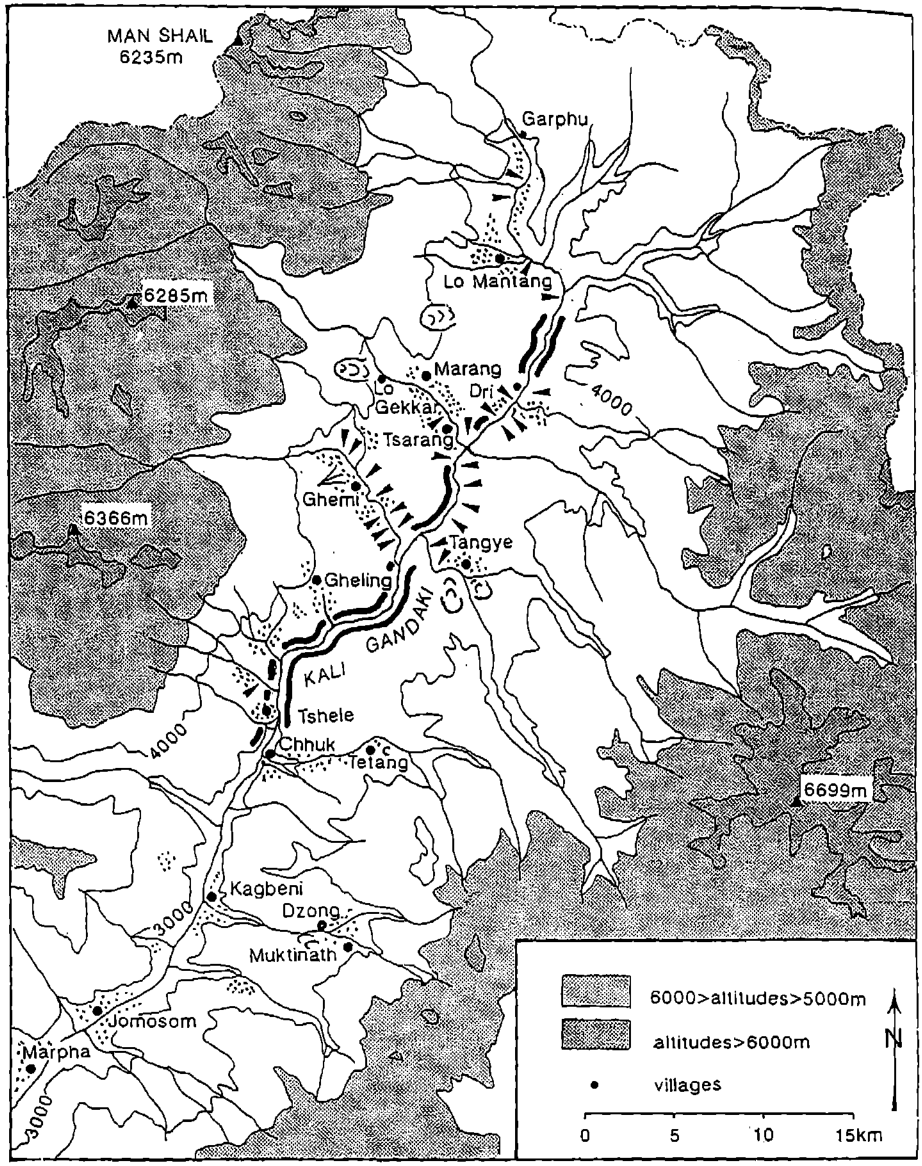


Figure 14.2: Topographic setting of Mustang area, with selected contour lines. From Tshele upstream, the Kali Gandaki valley is in fact deeply entrenched within multicoloured sediments, forming an impressive canyon with preciptious cliffs made up of red or yellow conglomerates, alternating with light blue or dark shales. Most of the villages are situated along the western, mountainous side of the Mustang "valley", where they take advantage of the presence of glacial melt-waters, sunny exposures and broad terraces sheltered from strong winds to develop their irrigated fields. Key: arrows: dissection; "C" symbols: masswasting; stippled terraces.

villages stretched along the edges of the Kali Gandaki flood plain (Jest 1966; Valeix 1974; Fort 1974). They were powerful traders for more than a century and, despite the closing of the Tibetan market after 1959, they are still a wealthy group, their farming activities being only a secondary source of income. In upper Mustang, where the climate becomes very arid and much colder (elevations >3000 m), Baragaon and Lo peoples live in compact villages, with an economy based primarily on irrigated agriculture in close association with livestock breeding and grazing (yak, sheep), and very secondarily on trade (Bista 1967; Fürer-Haimendorf 1975). In contrast with Thakhali, their settlements are not situated along the narrow belt of the main Kali Gandaki valley (with the exception of Kagbeni and Chhuk) but they are hidden in adjacent valleys, where they are better sheltered both from strong winds and from the possible attacks (in the early days), and where they are also closer to good quality sources of irrigation water.

A VERY DISSECTED LANDSCAPE

The specificity of upper Mustang, compared to other northern Himalayan areas, is primarily based on its contrasting topography, a result of both geological evolution (during the last five million years) and river activity in accumulating sediments and dissecting landforms.

Regional topographical contrasts appear in opposition between three units:

1. a massive and glaciated mountain culminating at Man Shail (6235 m) limited to the east by a steep scarp (>6000–4800 m);
2. an intermediary zone where subdued, east-west oriented, elongated ridges (4800–4000 m) alternate with extensive pediments and gently sloping terraces (3800–3400 m) upon which villages are situated, and
3. the deep canyon of the Kali Gandaki (<3400–2700 m), which is considered as an axis, but is also a gap, throughout the entire area.

The contrast between the two first units, mountain and basin (Photo 14.1), can be explained by the geological setting: the Mustang basin corresponds to a half graben, a tectonic depression delimited on one side by a normal fault, the "Thakkhola" fault. This fault separates an upthrown, mountainous block to the west from the Mustang basin in the centre. The reliefs created by the progressive uplift of the western side have been subject to rapid erosion, thus resulting in a voluminous production of debris. In fact, more than one-thousand-metre-thick sediments of various kinds (from coarse alluvial fan gravel to fine lacustrine silt, the "Thakkhola sediments") have accumulated and filled in the tectonic depression during the last two-to-five million years. The Thakkhola fault which bounds the basin is still considered active, as suggested by microseismicity studies recorded by the Seismological Laboratory of Kathmandu (M. Pandey, personal communication).

The contrast between the Mustang basin and the gorges of the Kali Gandaki and its tributaries relates to "recent" episodes in Mustang geological history (i.e., ~0.1-to-0.5 million years ago). The headward erosion of the Kali Gandaki River started to cut throughout the thick graben filling. This process was caused by the necessity for the Kali Gandaki to maintain its southerly course despite the continuous uplift of the Himalayan range. In order to adjust its longitudinal profile to the regional base level, i.e., the Ganga, the Kali Gandaki (together with its tributaries) was forced to deeply entrench its valley across the Himalayas and then to encroach further to the north, into the less resistant graben sediments, thus creating a dramatic, variegated, "chaotic and fantastic landscape" (Snellgrove 1961), often compared to the Colorado Canyon.

This northward erosion explains why the depth of vertical incision, therefore the topographic contrasts, are maximum in southern Mustang (1200 m), then decrease northwards (500–600 m near Lo Manthang). Actually, the carving out has not yet reached the flat Kore La pass, at the Nepal-Tibet border, but the process is still ongoing. Though very fast, in terms of geology, the incision rate has, however, not been steady during time, because of climatic changes that characterize the Quaternary era (alternance of glacial and interglacial periods). One former episode is of particular relevance to the present occupation of the area. Probably at the end of the next to last glaciation, powerful streams, fed by waters from melted ice, reworked huge volumes of glacial till and frost-shattered debris, predominantly gravel and sand. These sediments partially filled in the former dissected landscape (200-to-300-metre thickness), the top of this accumulation forming the extensive fans and terraces which are now major sites for the present settlements of upper Mustang (Photo 14.2).

Linked to this complex geomorphological history, two natural hazards appear as potentially dangerous in the Mustang area: (i) earthquakes (active tectonics) which may cause rare yet disastrous events locally because of their unpredictability; and (ii) ongoing active dissection, a low magnitude yet frequent process, which may significantly affect the sediments accumulated in the 'graben' and thus may threaten irrigated fields as described below.

A GRAVITY-FED IRRIGATION SYSTEM

This irrigation system is composed of a series of gravity-fed channels which usually branch out from glacial tributaries of the Kali Gandaki and run for long distances down to the villages, set upon alluvial fans or terraces. The mode of bringing water varies, depending on the distance of the villages from the mountain rim of the graben, and on the size of the streams. Some of the take-off canals start in the mountains, high above the villages, and must be carved into the bedrock (Gyakar). Most of the leats are, however, simple derivations of the stream, going from the bed down to the irrigated areas. They are dug out of the coarse gravel underlying the cones and terraces so as to maintain a regular gradient whatever obstacles may be encountered, boulders, etc. They are unlined, but they can locally be reinforced by cobbles. Along the major tributaries of the Kali Gandaki, such as the Qumona and the Tsarang rivers, where the water supply is illimited because of an extensive glaciated watershed upstream, several canals have been built at various elevations, thus allowing different terrace levels to be easily irrigated. In the Tshele case, however, the supply of water is more difficult because the village is located at the downstream edge of a 100 m high, narrow terrace, surrounded on three sides by very steep cliffs cut by the Kali Gandaki and its tributary (Gyakar Chu) into the Thakkhola sediments and Late Quaternary gravel. Many leats there are overhanging and wooden gutters are required as substitutes in some places. On the other hand, when the tributary supplies a limited amount of water (springs), it needs to be stored in reservoirs as in Ghiling and in the surrounding areas (Syangmochen and Chyunka). Reservoirs may also serve to retain silts and to provide the cattle with cleaner water.

Water is then distributed along the irrigated perimeter by a system of channels of varying sizes. The water is directed from one channel to another by shovelling the sediments off the levees (gravel and sand, and/or soil) or by using a sluice, usually controlled by a stone. In the fields, the flowing sheet of water is directed by small bunds of earth spaced about 1–1.5 m apart, shaped after ploughing is completed. The pattern of these small bunds varies according to villages: either very geometric as in Tetang (Baragaon) (Photo 14.3) or more irregular shaped in a curved or a herringbone pattern, as in Lo country. Water availability, variations of surface slope, variable area of the fields, together with social and ethnic elements, are certainly important factors for explaining these differences.

The distribution of water in time indeed depends mostly on socio-economical and political factors, and on the status of land ownership in particular. Throwing dice seems to be a frequent practice for water allocation in these north-western, Bhotia-influenced regions of the Himalaya, as mentioned in Marpha (Valeix 1974), in Baragaon (Fürer-Haimendorf 1975), in Dolpo (Jest 1975:106; Fürer-Haimendorf 1975:167) and in Zanskar (Osmaston et al. 1994). However we may surmise that in the Lo country, where the Raja used to own most of the land, a specific system must have existed. In general, the rules attributing water rights tend to become very strict when the supply of water is insufficient.

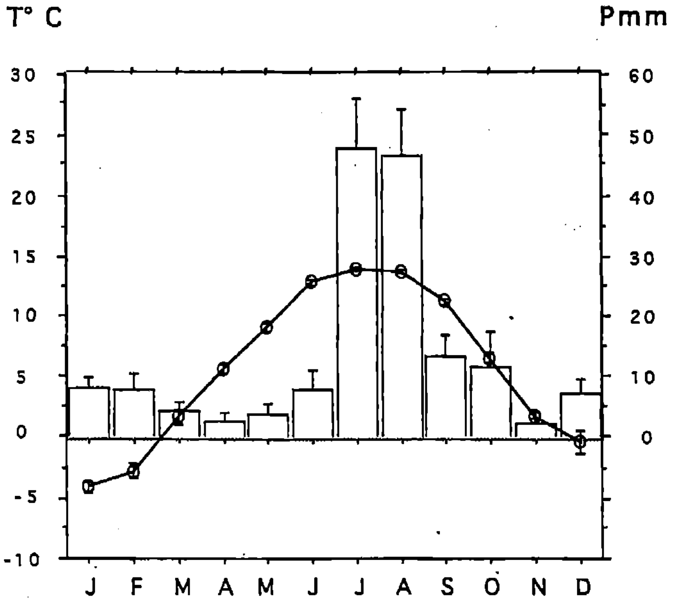
CLIMATIC CONDITIONS AND WATER SUPPLY HAZARDS

Regional and local climates control the regime of the many streams descending from the adjacent, glaciated mountains, and thus the variations in watering time and nutrient supply to the irrigation system. Additionally, the nature of the material which makes up the terraces where villages are situated determines some specificity of the irrigated soil.

Precipitation is very rare in the Mustang "valley ": 160 mm/year on average (1975–90), with a wide inter-annual variability. With 85 mm, 1982 was the driest year recorded so far, whereas with 296 mm, 1978 was the wettest. The annual distribution of precipitation (Fig. 14.3a) clearly shows that monsoon air masses, though starved, still play a dominant role: their fluctuating influence explains the higher precipitation variability of the wettest months, July and August. In contrast, the spring months (April and May), when vegetative activity starts again, are quite systematically the driest ones, thus making irrigated agriculture a necessity.

The amount of water availability is also controlled by temperatures. Freezing temperatures characterize winter, and water is scarce during this period. In fact, the temperature curve (Fig. 14.3b) reflects a continental climate, which in Mustang is not as severe as expected considering the altitudes and its position north of the Himalayan range (compared for instance with data from Dras or from Leh in Ladakh, quoted in Fort, 1983), though absolute minimum temperatures of -26° C were recorded during January 1977. The temperature curve displays a higher variability in winter than in summer, which is probably best explained by the situation of Mustang both at the easternmost influence of the westerlies and along the north-south trench of the Kali Gandaki, where tropical fluxes can penetrate north of the Greater Himalaya. Although average temperatures during the summer months are less variable, their daily range may be wide, with a maximum amplitude of 27.4° C recorded during July 1986. Evaporation is consequently very high, as indirectly attested by the xerophytic, steppic type of vegetation (*Caragana gerardiana* and *C. pygmaea*, *Lonicera spinosa* and *L. hypoleuca*, *Oxytropis mollis*, *Berberis* sp., *Juniperus squamata* etc.; Dobremez 1976).

The effects of valley winds are an additional factor affecting both humidity and air temperature. Channelized by the Kali Gandaki gorges, the winds can reach speeds far exceeding 100km/hour, and can also exert important mechanical actions on natural or cultivated vegetation. Fields are



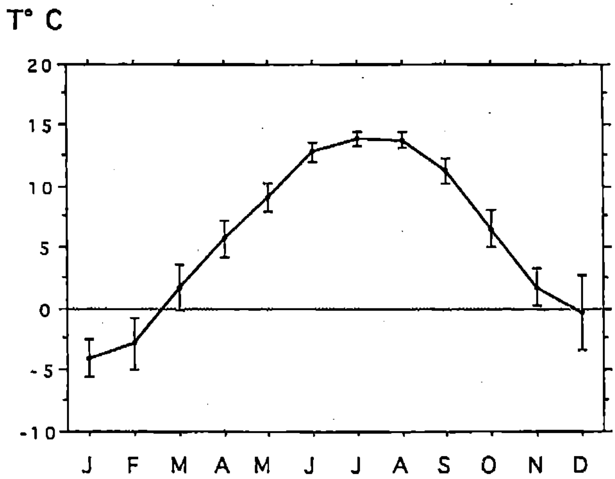


Figure 14.3: Climatic characteristics of Lo Manthang (Mustang). Diagrams established from Climatological Records of Nepal, Department of Meteorology and Hydrology, Her Majesty's Government of Nepal, Kathmandu.

a: Temperature curve, established from 13-year-data collection (1974–86). Bars indicate standard deviation.

b: Mean annual precipitation histogram, established from 16-year data collection. Note the sharp contrast between a long, very dry spring and a very short, "water" summer. The absolute values of precipitation are, however, very low, and the availability of water is furthermore limited by strong evaporation, reinforced by violent up-valley winds, and by snowfalls which are more frequent than rainfalls.

increasingly surrounded by mud-bricked or boulder walls, a practice aimed at protecting fields both from wind (gardens, tree plantations) and from free-grazing cattle.

The stream regime is ultimately characterized by a marked winter minimum (frost), in contrast to a late spring/summer maximum (snow, followed by glacial melting). At a shorter time scale, this regime presents strong diurnal contrasts (arid continental climate), and in the graben itself, it is dependent on limited, sporadic precipitation. Snowfall may occur anytime during the year, usually followed by a very fast and thus concentrated melting. As a result, snow storage is limited and cannot balance the climatic hazards (see below). Finally, this regime is amplified both by the local topographical configuration, i.e., the steep slopes and the eastward aspect of the mountain flanks, both factors which reduce the lag-time between any given climatic event occurring in the mountains and its response to stream discharge in the graben.

The stream regime also influences water quality, which therefore varies with time. Whereas in the morning, low discharge and clear water predominate, the midday heat results in higher discharge (glacial melting in the mountains), and therefore in muddy waters, richer in nutrients (transport of suspended silts) even where acidic bedrock such as granite predominates (motion of crushed feldspars and micas derived from glacial sediments), as in the north-west (Fig. 14.1).

Coarse debris do not usually enter into the irrigation system, although the voluminous transport of material can locally take place along the many streams descending from the west side of Mustang. In fact, irrigated fields are rarely found close to the streambeds, probably both because the populations are well aware of the erratic, unpredictable behaviour of the streams (see below) and because of the lack of space in these narrow, entrenched canyons. As already mentioned, settlements have developed on perched, wide terraced flats with the irrigated fields surrounding them. In that respect, irrigation canals are a good adaptation to the irregular stream regime, since they control sedimentation rates.

SOIL CHARACTERISTICS AND HAZARDS

Noticeable differences do indeed appear from one terrace to another, depending on the soils' texture and their cohesion, which are influenced by their petrographic and mineralogic components, i.e., indirectly by the geological environment.

1. Sandy, porous soils are dominant in north-western Mustang (from Ghemi northward), where streams drain across granite terrain. In order to acquire

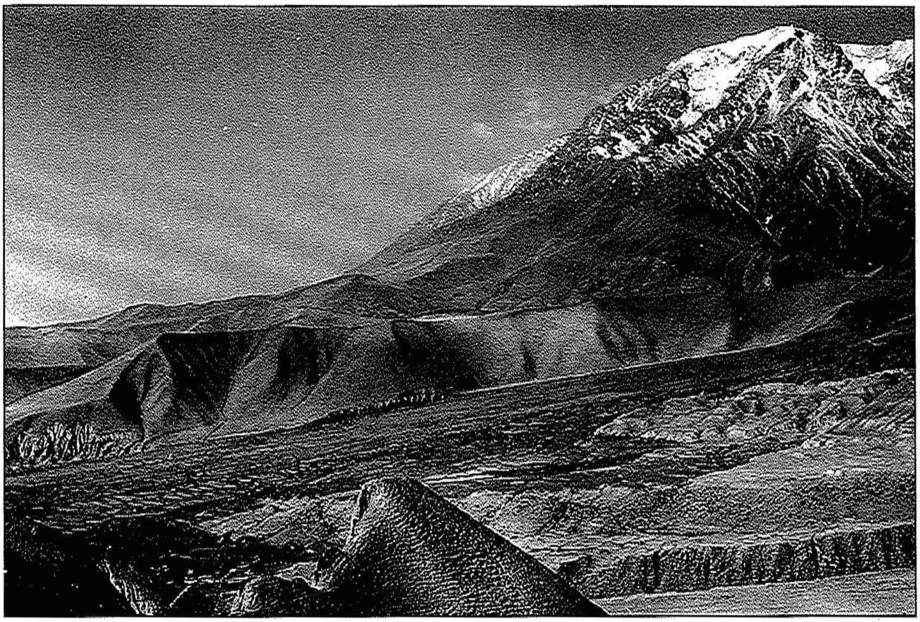


Photo 14.1: General topographical context of Mustang, an intra-montane basin of the northern Himalaya: a fault scarp to the west (right), the villages and irrigated fields on glacio-fluvial outwash cones (lower third), these cones inset into lower ridges carved out of the graben filling (background). Water is generally derived from the glaciated mountains and, more rarely, from local springs (Fort, April 1993).

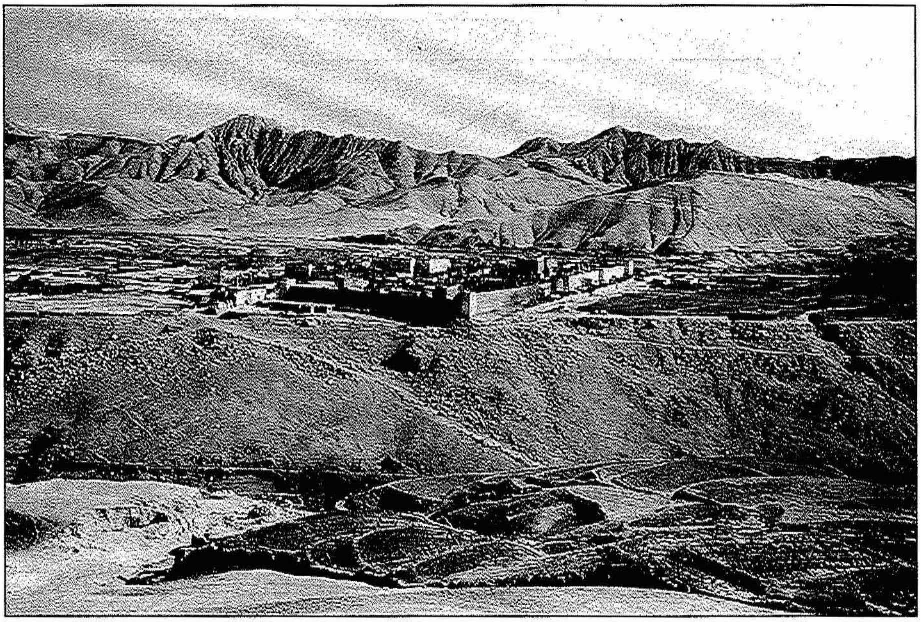


Photo 14.2: The site of Lo-Manthang (3600 m), the capital of Mustang, viewed from the north. The walled city is situated on a wide glacio-fluvial fanglomeratic terrace, corresponding to the distal part of the glacio-fluvial outwash cone as the one displayed in photograph 1 (see the size of the granite boulders, near the footpaths, some exceeding several metres in diameter). The irrigated fields extended on the gently sloping fan and on the terrace sides. The valley is draining eastward (left) towards the Kali Gandaki (Fort, April 1993).

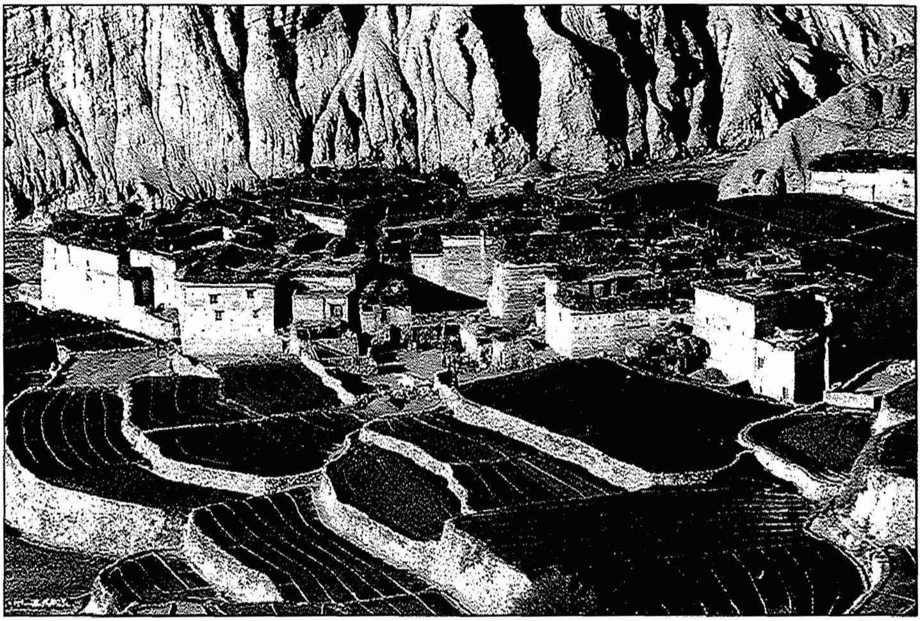


Photo 14.3: The site of Tetang (3000 m). This fortified village, probably the oldest in the Mustang area (Ramble 1994), is developed on the outward edge of a steeply dissected torrential debris fan. Upheld by one-to-five meter boulder walls, the fields are subdivided by internal bunds built to evenly distribute irrigation water. The background shows the Mustang graben sediments, very severely dissected into vertical columns like giant organ-pipes (Fort, April 1994).

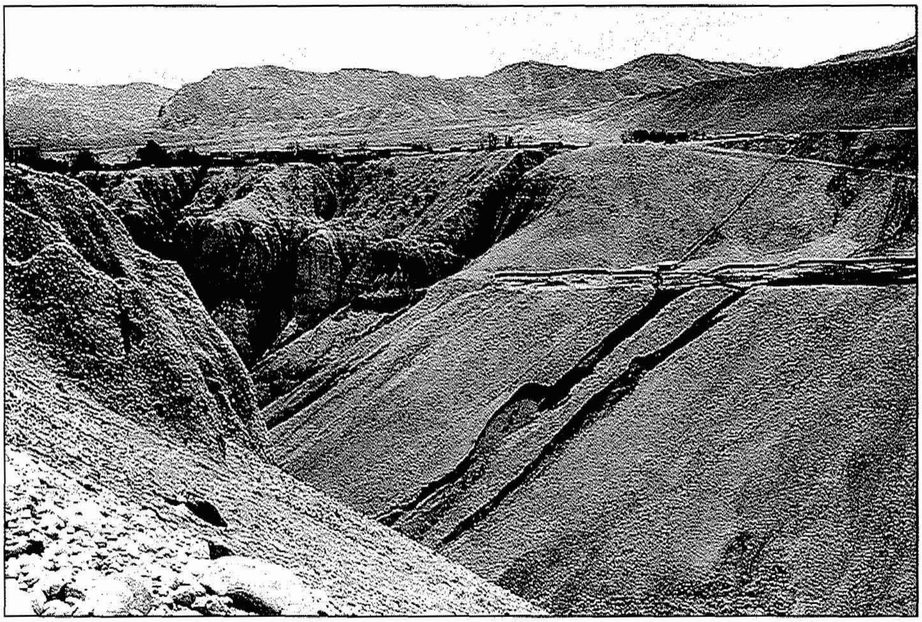


Photo 14.4: Misuse of water, Charang village (3550 m). Water drains out of the irrigated fields (right) and from the small powerhouse without proper control. This result in severe gullying and a further threat to the newly settled irrigated perimeter on the middle terrace (Fort, April 1994).

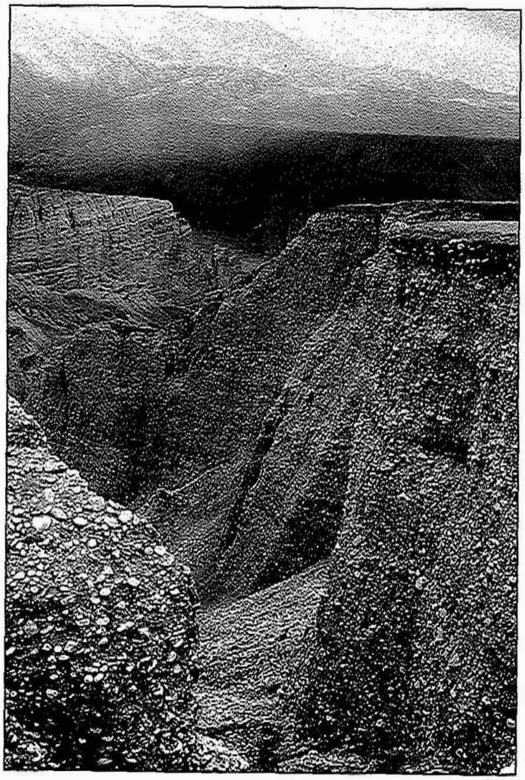


Photo 14.5: Headward erosion from the Kali Gandaki river (3300 m, bottom background) in progress along major tributaries. This erosion, here encroaching on the easternmost cultivated part of Charang terrace (3500 m), causes the loss of irrigated fields (Fort, April 1994).

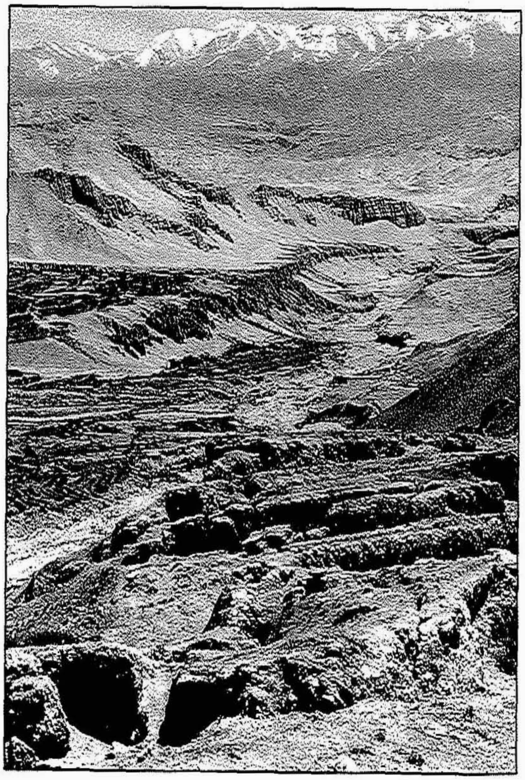


Photo 14.6: Upper Jhong valley, opposite side from Muktinath, viewed from the ridge bounding the watershed to the south. Irrigated fields of Purang (lower foreground) and Jhong village 93500 m, central middle ground) are inundated by meltwaters from the glacial cirques of Khatung Kang 6844m, northwestern face). The main irrigation canal strikes horizontally across the slope, which is severely affected by a complex system of slumps, as clearly indicated by the arcuated headscarps outlined by lighter colors. The entire side of the valley is in fact continuously sliding, because of the shaly bedrock easily saturated and soaked with snowmelt waters during several months per year (Fort, Nov. 1978).

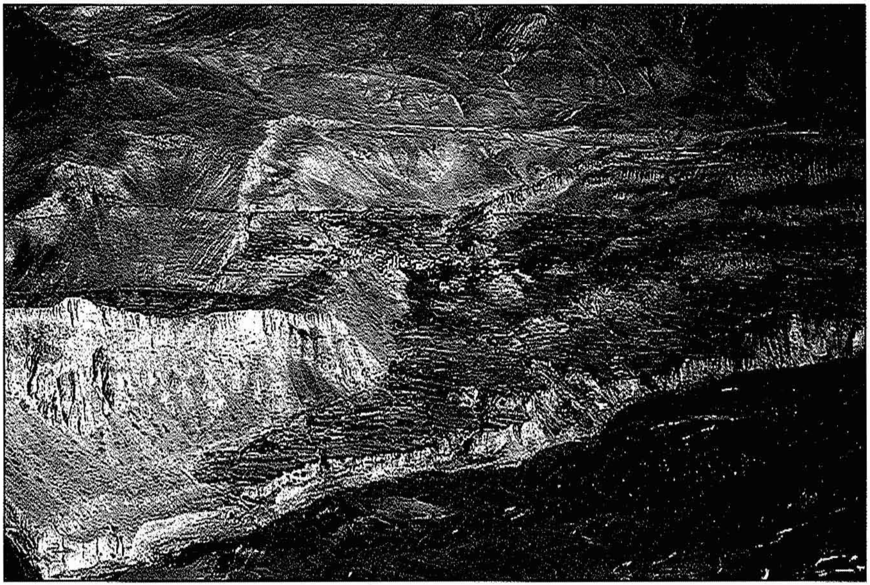


Photo 14.7: Upper Jhong valley, running east-west (left-to-right) toward the Kali Gandaki. The snowy "Grande Barrière" (left) and Tilicho Peak (7132 m, right) belong to the Greater Himalaya (background). The north-facing slopes of the valley (middle ground), covered by a shrubby discontinuous vegetation, are subject to active mass-wasting processes (mostly rotational slides and earthflows). The superficial dynamics are caused by the black shaly, clay-rich substrate, which moves and flows when saturated with water. Although slow, the sliding process is continuous in time because of the constant rejuvenation of the earth-flow toe by fluvial downcutting and undercutting. The permanent denudation of the bedrock brings into outcrop many fossils of Ammonites, called "saigrams" by the Hindu pilgrims visiting the Muktinath shrine, located a few kilometers upstream this valley (Fort, Nov. 1978).

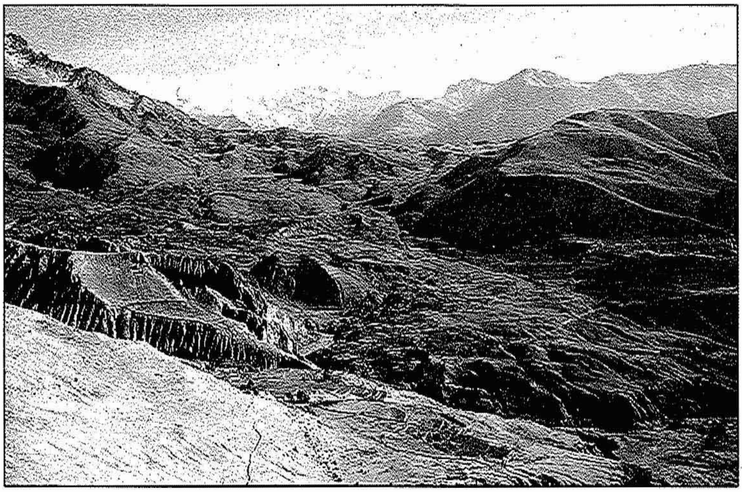


Photo 14.8: Upper Charang valley, with the village of Marang visible in the middle ground (left side). The north facing slopes (foreground) are subject to mass-wasting (rotational slides), due to the shaly substrate (Primacy schists). Open cracks observed on the foreground concentrate the waters brought by precipitation and snowmelt, thus reinforcing further sliding and collapsing of the entire slope (Fort, April 1994).

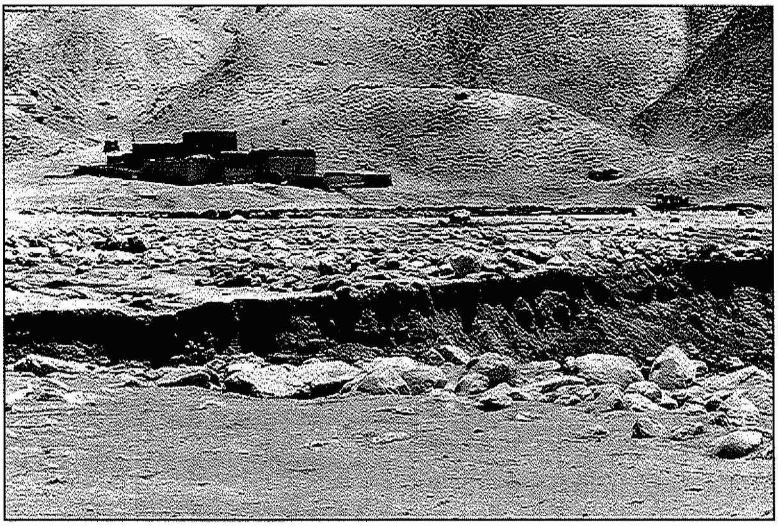


Photo 14.9: Upper Mustang can be affected by catastrophic floods, originating in the glaciated Man Shail Range (6235 m) delimiting the Mustang basin to the west (see Photo 14.1) In 1988-89 the irrigated fields of Garphu were destroyed by an unpredictable glacial flood and by the subsequent accumulation of boulders which filled and spread over the former river bed (here an upstream branch of what will become the Kali Gandaki further downstream). The house in the background is a new farm, constructed after the former farm, located closer to the river bed, was swept away by the 1988 flood (Fort, April 1993).

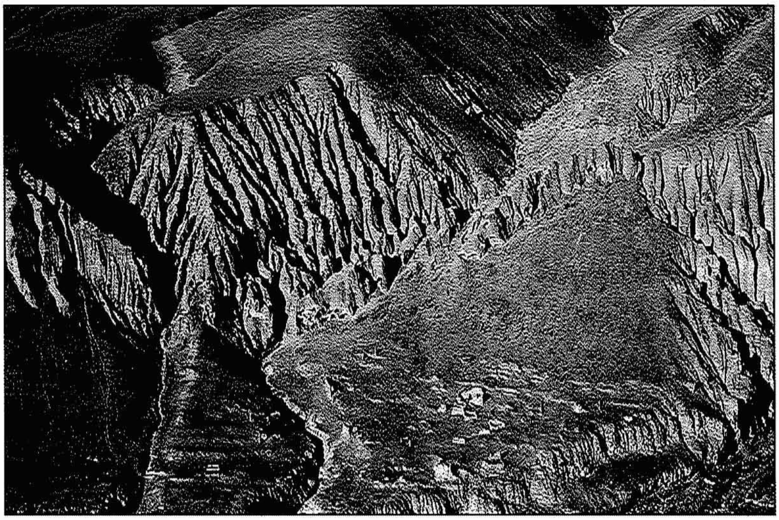


Photo 14.10: Upstream Kagbeni, the abandoned village of Phudzeling was settled on a lower terrace of the right bank of the Jhong khola (a left bank tributary of the Kali Gandaki). The villagers, who also used the caves (left middle ground), were obliged to abandon their settlements at an unknown period because of the destruction of their irrigation canals and the subsequent ruining of their fields, that were caused by 1) undercutting by the Jhong river of the loose, diamictic sediments (debris flow material) underlying the lower terrace (lower right), and by 2) severe gullying affecting the adjacent slopes made of glacio-fluvial and colluvial deposits (background). These natural hazards may be related to periods of higher geomorphic intensity, that may have been tiggered either by some exceptional climatic event or by an earthquake (cf. the vicinity of the Muktinath fault) (MF.NE.78.28.15)

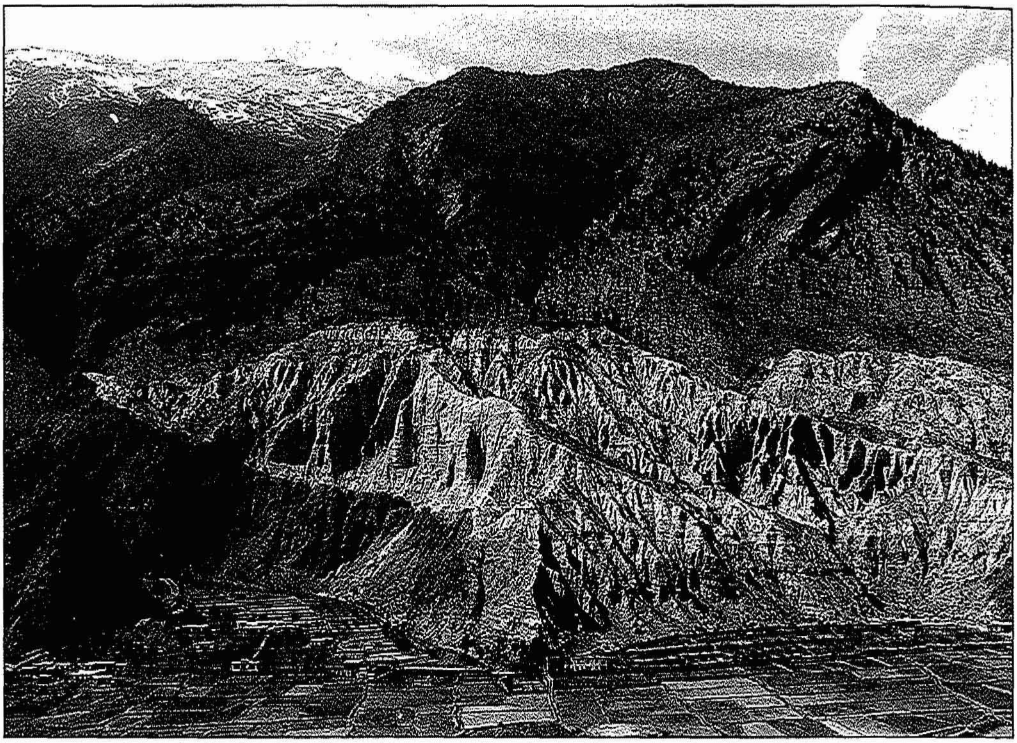


Photo 14.11: Right bank of the Kali Gandaki, south of Marpha, looking at the site of the Governmental Horticultural Farm (left side) created by Pasang Khambache Sherpa in the early 70s. The farm is settled on a fan built up at the mouth of a very deep canyon cut into the Palaeozoic (Devono-Silurian) bedrock (outcrops in the background). During the fall 1973, the gardens were destroyed by voluminous flash flood and debris flows, triggered in the upper catchment by intense rainfall, rapid runoff and subsequent erosion. The same event also caused the reactivation of the gullies carved out of the whitish, limy lacustrine beds displayed in the middle ground. These beds represent the remnants of a large, 20-km long, nearly 200m-deep, landslide-dammed lake, which once flooded the entire Kali Gandaki valley up to the north of Kagbeni (described in Fort 1980) (MF.NEP.82.07.10)

a texture stable enough for irrigation, this soil requires significant additions of silt particles, that may be provided directly by the glacial milk carried by the glacial melted water, and/or by organic matter provided by both animal and human manure.

2. Clayey soils, derived from dark schists and shaly outcrops, are, however, prevalent throughout Mustang (from the Lo Gekkar and Marang areas to the Tangye, Tetang and Muktinath zones). This soil may be subject to alternances of humectation/swelling and desiccation/shrinking. The opening of cracks during the dry season may cause the diversion of water out of the irrigated perimeter. The same holds true for soil developed upon lacustrine strata in the Marpha area (southern Mustang), where lime, silty components may also favour piping.

Whatever these differences are, in fact, the close association in the villages of cattle-raising and agriculture allow the fields to be fertilized by a mixture of composted human and animal waste, which improve the soil's textural strength. Careful management makes this soil quite rich with potential high yields. Some problems, however, cannot be avoided.

As already mentioned, silt and nutrient concentration may be significantly influenced by short-term variations in water discharge, mainly caused by the irregular, unpredictable and rapid succession of weather (storm precipitation, exceptional heat). Because of the high evaporation rate, these variations allow salts to accumulate locally in the soil, as observed in the marshy meadows west-south-west of Lo Manthang. These consequences are particularly serious in areas where the geological bedrock is rich in salts. This is observed around Dri or upstream of Tetang village, where salt mining has always been a traditional source of income. Everywhere, and particularly in these places, continuous overland and through-flows across irrigated fields should be performed in order to avoid risks of calcretization or salinization, otherwise the fields would have to be abandoned.

GEOMORPHIC HAZARDS

Fig. 14.4 summarizes the water and sediment paths that are involved in the irrigation system of the Mustang area. It also provides an idea of what the main physical constraints are and where they control the system. Several geomorphic hazards may affect the irrigation system at various degrees: run-off and gullying, mass-wasting (from debris-flow to landslides), and catastrophic events. We shall present them by order of importance and their impact on human activities. Although some problems may occur within the irrigated fields, partly caused by mismanagement, major, naturally induced threats prevail, and their occurrence is more frequent in two main areas, i.e.,

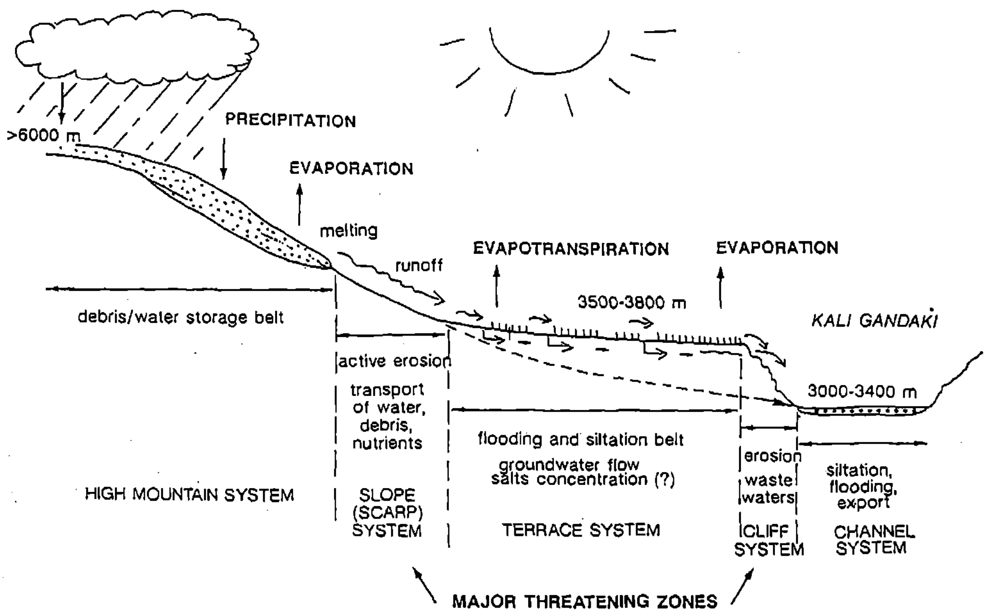


Figure 14.4: Conceptual scheme presenting the main components of the irrigation system of the Mustang area. Five belts are individualized, with their characteristics. Note that the vertical section is not at sale.

at the transition zone between the fault scarp and the terraces, and between the terrace riser and the gorges below (Fig. 14.4).

1. Rill and Gully Erosion

Fluctuations of the water flow-pattern and the volume inside (leakage) and at the periphery (wastage) of the irrigated perimeter is a first threat, which may induce runoff and favour subsequent rill/gully erosion. Two situations are indeed encountered.

Firstly, inadequate water control by people can exist locally. When the water is not properly channelled downstream to rejoin the main stream, overland flow at the periphery of the irrigated perimeters causes downcutting which, by headward erosion, will soon encroach upon the irrigated fields, thus inducing a decrease in crop yield and a direct loss of irrigated areas. This is easily observed in lower Mustang, around Tshele, Chhuk and Tangbe. The site of these villages corresponds to the very edge of terraces overlooking the main Kali Gandaki valley, a site which increases the danger of headward erosion by irrigation wastewaters. A different situation is observed at Tsarang, where mismanagement is particularly obvious (Photo 14.4). The construction of a small hydroelectric plant to supply the village did not receive careful attention: the used water was not channelized and, five years after the project's completion, the water began to dissect the terrace slope, which may in turn threaten the plant's stability and the adjacent irrigated perimeter on the intermediate terrace.

Most often, however, gullying is a natural process triggered by heavy, intensive rainfall occurring on desiccated, soft bedrock. In that respect, the marly and loamy beds frequently outcropping from Ghemi northward are easily subject to this threat. Opposite to the present Ghemi village, settled on a right bank terrace (+100 m) of the Qumona Chu, the former site of Ghemi village is still highly visible downstream, perched on a left bank terrace of the same stream. The village had to be abandoned at the beginning of this century, after the destruction of the main irrigation channel was caused by severe and deep gullying in the soft, marly and silty sediments of the graben. As pointed out by Gurung (1980), the unusually long *mendong* (prayer wall) bespeaks of "the past grandeur of the village", the decline of which is directly linked to natural factors.

Similar destruction by gullying and, more generally, by headward dissection from the major streams is also a plausible cause, among others, for the abandonment of some early cave dwellings, by erosion and the collapse of the infrastructures allowing access to the caves (Simmons et al., 1994), such as upstream of the Qumona Chu (opposite to Ghemi village), on the right bank of the Kali Gandaki (opposite to Chhuk, and on the right bank of the Narsing khola (downstream Tetang). The most spectacular effect of headward erosion may be observed at the easternmost edge of the Charang terrace, overlooking the Kali Gandaki valley (Photo 14.5).

2. Mass-wasting Hazards

Besides the action of concentrated waters, **mass-wasting** affecting slopes is a frequent process because of the conjunction of several factors (type and variability of precipitation, steep slopes, adequate bedrock, etc.).

(i) **Debris-flows** are very common in this type of alpine, arid environment. They particularly and easily affect the soft "Thakkhola" sediments accumulated in the tectonic depression. Several examples are noticeable in the Qumona valley. South of Ghemi, an active debris flow has reworked the several-hundred-meter thick accumulation of gravel, which is spread over the cultivated terrace and encroaches northward over the irrigated perimeter. It is quite possible that this process is furthermore accelerated by the passage of cattle going up to the alpine pastures above 4800 m, yet the origin of the process is natural. Debris flows may, however, affect more extensive catchments. When channelized, debris flows often evolve as flash floods downstream, as observed south of the Mustang area, near the confluences of the Kali Gandaki River with its glacial tributaries. For instance, south of the villages of Jomosom, Syang, Marpha and Tukuche, the huge alluvial fans, which force the Kali River to swing from one side to another side of the valley, are fed by destructive debris flows or flash floods, triggered by abnormal melting of ice and/or rock/moraine/ice collapse taking place in the upper watersheds. These floods occur on average once every five to ten years (Fort 1987). The experimental farm of Marpha was thus destroyed in 1973 (Gurung 1980) (see also, Photo 14.11). The Narsing khola, which split the Chhuk village into two settlements, is another example of a stream affected by erratic, debris-laden flows, as displayed by the coarse material dispersed over the present river bed and by the fabric of the sediments (boulders embedded within a muddy matrix) making up the adjacent lower terrace.

More generally, upstream configurations, such as steep slopes and deep gorges, may lower the response time between the event and its effect upon the irrigated land, thus increasing the risks for downstream settlements.

(ii) Landslides are a rather specific geomorphic hazard of the Mustang area, because of the extent of clay-rich rocks (Spiti shales, Permian schists, etc.), able to flow when saturated with water. The dark Spiti shales, famous all over the Himalaya because of their Ammonite fossils (or *Saligrams*, worshipped by the Hindus as representing the god Vishnu), are particularly prone to complex mass-wasting including slumps (Photo 14.6) and earthflow features, as observed near Jharkot, in the Muktinath valley (Photo 14.7). The vicinity of Tetang and Tangye villages is particularly marked by this instability. The slopes located upstream Tyangye watershed display a very irregular, hummocky topography which reflects the ongoing process of slow creep and slumping in the outcropping dark, Spiti shales, whereas south-east Tetang, the same processes destabilize and cause the collapse of the overhanging cliff, thus triggering unpredictable rockfalls. An important condition for these landslides to occur is the local concentration of water. In addition to the possible existence of a spring line, this concentration is temporarily possible after a huge snowfall, followed by a rapid elevation of air temperature and the consequent acceleration of the melting, which favours the saturation (soaking) of the shaly bedrock. Local configurations, such as aspect or slope degree, may also help. In the Muktinath valley (Photo14.6), for instance, the slopes facing north receive more moisture than others due to a longer duration of the snow cover during winter and spring, a characteristic which is further exploited by the inhabitants as fields and good pasturelands.

The case of Lo Gekkar, a monastic settlement installed upstream from the Charang valley, is even more dramatic: the whole side of the terrace slope, made of Primary schists, is collapsing (Photo 14.8). It is affected by a series of rotational slides, forming a kind of gigantic staircase in the landscape, each step being separated from the other by wide (>1 m), open cracks. These cracks in turn allow more water to penetrate and saturate the bedrock in depth, thus reinforcing further sliding and collapsing of the slope. The presence in this area of abandoned, irrigated fields was striking, yet it has never been considered as a suitable place for agriculture. As local people reported, these fields were an early attempt by the monastic community to extend their crop resources, although they had to give it up rapidly.

3. Seismotectonic Instability

The current instability of the mountain front is related to the activity of the Thakkhola fault which, in combination with the presence of a huge storage of glacially, and periglacially, derived material, may eventually trigger extreme catastrophic events and cause the destruction of the system, as observed in the Chhosar (Garphu) and Kali Gandaki valleys.

In 1988 (or 1987?), as reported by local people, a huge flood devastated this upper valley, destroying houses and fields, killing several people and cattle, and ruining high pasture meadows (Fig. 14.5). Five years later, the geomorphic evidence of the flood was still extremely clear: metric granite boulders (derived from the Man Shail massif) spread over the present talweg and the lower terraces (Photo 14.9) for more than 30 km in distance; sheets of white granite sands observed as far downstream as the confluence of the Kali Gandaki with the Charang Chu. According to the local people, this event was not directly related to exceptional precipitation. In fact, the sudden rise of the flood and its capacity to carry big boulders suggest that the flood had an infrequent and remote origin.

The cause for this flood is still not clear, because it occurred in a remote area and there is no witness to the origin of the event. The outburst of a lake is probably the source of this sudden input of water. Two possible, non-contradictory, explanations are considered.

1. The diachronic analysis of satellite images has shown that a lake has developed in the Man Shail range during the last ten years, and that it had accumulated in front of the present glacier tongue behind morainic ridges built up during the last centuries (Little Ice Age). This lake had been recorded as potentially dangerous and susceptible to outburst by the Water and Energy Commission Secretariat (P.K. Mool 1995). The

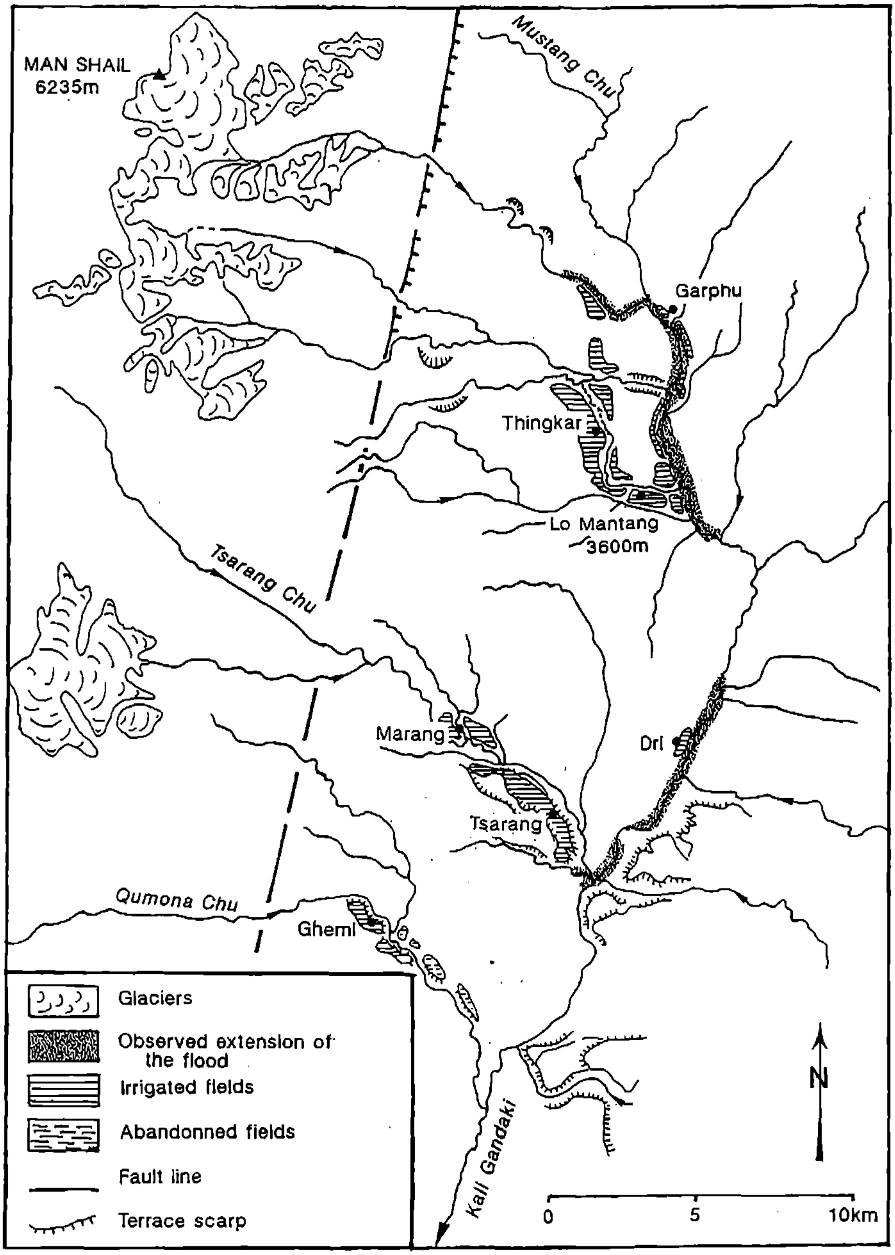


Figure 14.5: Extension of the catastrophic flood as observed from Garphu down to Tsarang. The origin of the flood has probably taken plae near the front of glaciers (arrow). The propogation of the flood was accompanied by erosional features (bank cutting and collapsing) and irregular sedimentation of granite boulders and sandy sheets. The effects of the flood were felt more than 40 km distance downstream.

potential causes for lake outburst are various, among which seisms are frequently quoted (Ives 1986).

2. Local people also mentioned the blocking of an upper valley by a huge landslide, and the subsequent formation of a lake upstream, the breaching out of which could be the direct origin of the flood. When questioned about earthquakes, inhabitants said they are used to feeling earth tremors from time to time; more specifically, they remember well one earthquake which occurred two months before the 1988 flood, and which, according to them, caused the landslide failure.

Whatever the exact nature of the processes involved, it is quite probable that seismic events, linked to the vicinity of the active Thakkhola fault, are a potential initial cause for either the break-up of a morainic lake dam or for generating landslide dams, both scenario leading in any case to destructive floods, which are quite dramatic in this arid region.

4. Climatic Change

Some long-term factors (more than one generation in time, i.e., >30 years), such as changes in glacial storage since the last century, may ultimately threaten the existence of the irrigation systems, and potentially cause the abandonment of settlements. Climatic change is a recognized factor for explaining the disappearance of brilliant civilizations (Indus, Mesopotamia, silk road oasis, etc.); it may also explain the abandonment of some sites of Mustang during the last decades (upstream Kagbeni? Marang?) (Photo 14.10). The recession of glaciers observed during the last century, in particular the retreat from the Little Ice Age moraines, induced severe changes in glacial-front topography, in the position of glacial melt-water channels and in the pathways of the water cycle. This drastic shrinkage of glacial storage in some upper valleys may condemn existing irrigation systems in the near future.

DISCUSSION

In Mustang, both the harsh environment and dissected topography, and the severe, natural hazards that may threaten (or had threatened) the irrigation system, necessitate important maintenance efforts that require both a strong willingness and social organization from the diverse groups living in the area.

In the very recent past, in fact, two features have modified the appreciation of the economic life in the area: the extent to the Mustang area of the

Annapurna Conservation Area Project (ACAP) action, and the influx of wealthy tourists in this Buddhist region.

In term of agricultural development, recent trends indicate that the Mustang economy relies more than before on agricultural production, i.e., on the management of irrigated fields. This is certainly due to the action of ACAP, whose Mustang Branch (in Lo Manthang) is supposed to receive the greatest part of the entrance fee paid by tourists and to reinvest that income in small-scale conservation and alternative energy projects, besides other actions more oriented towards the preservation of cultural and architectural heritage (Snellgrove 1961; Jest 1981). These projects, such as tree plantations (either private or community), agro-forestry nurseries, construction of micro-hydroelectric plants and solar energy plants, etc., are an attempt at resource management, in order to develop the production potential of the area, to alleviate pressure on the degraded steppes and/or on the *Juniperus* and *Cupressus* open forests, and finally, by combining environmental protection with sustainable community development and tourism management, to raise the living standards of the local people.

Besides its contribution to ACAP's budget, the real impact of tourism in Mustang is still difficult to assess because the opening of the area is too recent (October 1992). As far as ecological impact is concerned, the conditions of access and the rules controlling visitors are quite strict so that any further degradation of this fragile desertic environment should be very limited. Access is reserved to such tourists who can afford to pay an entrance fee of 70 US $ per day; individuals are not allowed to travel by themselves, only groups of trekkers under the guidance of travel agencies and a liaison officer are accepted. These groups must carry all they need (food, fuel, equipment) and they are obliged to carry back all non-burnable and non-biodegradable garbage. These strict rules do not seem, however, to apply to the accompanying trekking guides and porters.

Contact with wealthy westerners may, also, have some impact on the Mustang people and on the economy of the area. It is often said that the sudden exposure of inhabitants of a remote region with different cultures and habits may cause the death of the local culture and religion. This might be true for a part of the population of Mustang, yet there is an old tradition of seasonal migration of Lobas (Lo people) to India during winter, when the climate in Mustang is too harsh with no agricultural activities. The "cultural shock", if any, is already behind. Lobas are selling "Tibetan", supposedly "old", items in the most touristic places of New Delhi, and they already know what profit they can make from westerners. With the opening of Mustang, they now try to continue this business back home, and this business is also beneficial, at least for some of them. Another impact might appear in the development of infrastructures (trails, hotels and lodges) which are quite inexistent so far. These infrastructures might have a positive effect on

Mustang agriculture, by boosting vegetable and fruit cultivation for selling to visitors (Photo 14.11); yet, this may create other problems such as overproduction and surplus stocks (as has been observed in lower Mustang in the Thakkhola area), and an increase of grain importation for local consumption. An increase in the number of horses and mules might be another positive adaptation to tourism, at least for some families among the richest and the closest to the Raja.

The probable evolution of their economy towards a more market-oriented type may cause the inhabitants of Mustang to lose interest in painstakingly maintaining their traditional, irrigated cereal lands. Finally, and more generally, the recent change may cause a break-up in the diverse segments of the population, depending on their differential control on resources and on their varying strategies and possibilities in achieving their goals, i.e., raising in their standards of living.

CONCLUSION

Inhabitants of Mustang can, to a certain degree, adjust to the effects of natural constraints by a deeper understanding and a careful, steady maintenance of the irrigation system. Yet, the difficulty for villagers in overcoming the impact of severe, unpredictable hazards may reveal potential ruptures in group cohesion and/or may induce a change in group strategy, economy and social life. It is probable that the recent change observed in the economical conditions will modify the perception of potential resources by the local people of Mustang. This represents the beginning of a long-term mutation of the entire society and of interactions between the environmental and socio-economical systems, which are becoming more complex. In that context, what will be the future of the water management system?

ACKNOWLEDGEMENTS

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15

Drylands Irrigation in a Wetlands Area: The Example of Aslewacaur in Central Nepal

Olivia Aubriot & Jean-Luc Sabatier

Aslewacaur, the case study site, has an irrigation management system similar to those observed in arid countries, however it is located in a monsoon area. How can the presence of such a system be explained? Irrigation is indeed required to cultivate wet rice in Aslewacaur, but the precision with which the water is shared is not a necessity to the local environment. There is no ecological determinism that could explain the presence of such a sophisticated water distribution system in this region of central Nepal.

The Site

Aslewacaur is located in Gulmi District in central Nepal (Fig. 15.1), in the middle hills encompassing elevations from 400 to 3000 metres. This district comprises two types of population: the Magar, a Tibeto-Burmese tribe, at present highly Hinduized, and the Indo-Nepalese, migrants from northern India, who settled in the area from the sixteenth century onwards. Ancestors of the Indo-Nepalese imposed the caste system, based on the traditional Indian one. The high castes (Bahun and Chhetri) still maintain political control of the country. Aslewacaur, a village of 150 families, is essentially (at 85 per cent) populated with Bahun,[1] most of whom belong to the Pande "clan"[2] (*thar*). Most villagers are landowners and canal users.

The irrigation canal of Aslewacaur is 100-years-old. It was built on a villager's initiative and was excavated from 1893 to 1896 by local workers. The water originates from a small stream and is channelled down a very gentle gradient to a high alluvial terrace of the Kali Gandaki River. Located at an elevation of 750 metres, Aslewacaur is 200 metres above the

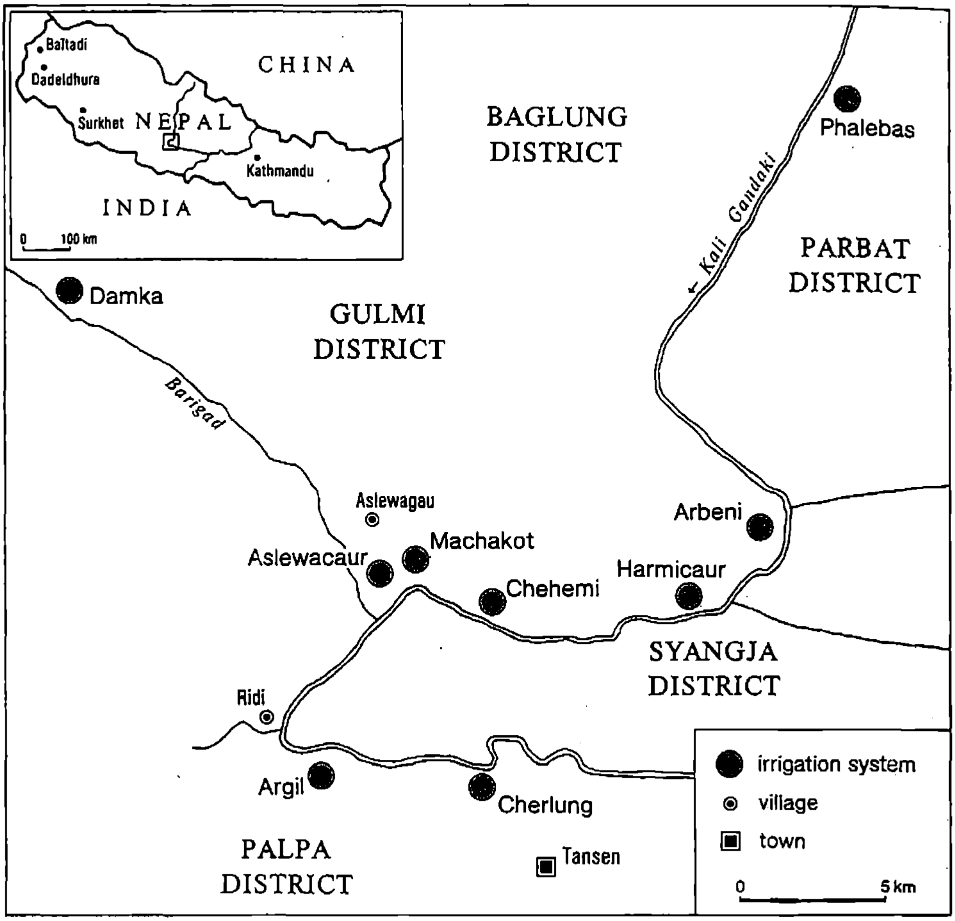


Figure 15.1: Location of the various irrigation systems mentioned in the text.

confluence of the Kali Gandaki and Barigad rivers. Its 35 hectares are cultivated with rice during the monsoon season followed by wheat and maize during winter and summer.

Located in the southern part of the Himalayan range, it is exposed to monsoon influence. Large amounts of precipitation are then recorded between the months of July and September. Eighty per cent of the rainfall, 1200 in Aslewacaur, occur during this period. Nevertheless, even during this rainy period, irrigation is required for wet rice cultivation. The following is a discussion of water distribution in Aslewacaur.

WATER DISTRIBUTION SCHEDULE IN ASLEWACAUR

After being diverted from the stream, water is channelled along a six-kilometre-long earth canal, which follows a contour line on a hillside with very steep slopes (photo 2). A proportioning weir, called a "*saco*" (literally "key"), divides the main canal into three secondary canals: *upallo dharo, majh dharo* and *cheuko dharo*[3] (photo 3). On each secondary canal, four water turns of twelve hours each (from 6:00 a.m. to 6:00 p.m., and from 6:00 p.m. to 6:00 a.m.) succeed one another. The local definition of water turn (*paniko pallo*) is used, namely the duration in which a determined block of plots is irrigated. This is in contrast to the definition commonly used by engineers, namely the duration between two irrigation applications in one plot; in other words, the time needed to irrigate the total area.

Water turns have names in Aslewacaur. The names of the water turns are those of lineages. A water turn irrigates the plots of lineage members and bears the same name.[4] Such an organization implies that the irrigators of a water turn are close relatives and are all from the same lineage. Organization of the water turns hence follows a logic based upon kinship relations,[5] and the system has been conceived according to local social organization. The block to be irrigated during the time of the water turn also takes its name from the water turn by extension. Through this correspondence it is possible to map the water turn distribution, as shown in Fig. 15.2.

Each secondary canal successively distributes water to four water turns. The canal named the *cheuko dharo*, for example, distributes water to the following water turns: "Bagale Dhanapathi", "Bagale Dinamoni", "Bagale Pareri" and "Laure". The water turns follow an alternating sequence in order to avoid their occurring only at night or in the day. If the first order is A, B, C, D, it will be followed by B, A, D, C (Fig. 15.3). Moreover, within a water turn, an egalitarian rule has also been established concerning water distribution. To avoid the tail-end farmers always being the last to receive water, the order of water distribution to the rice fields is also alternated. If water is first delivered to the upstream fields, followed by delivery to the fields below; then in the subsequent turn, the downstream fields are irrigated first and only then water is diverted to the upstream fields.

At any given time, all the water from the secondary canal is diverted into a single field, with one farmer using all the water at once. In practice, the farmer blocks the canal with a stone and some mud, and with his hand diverts all water from the canal into his field through a notch in the field bund. When his irrigation time expires, he clears the canal and blocks the notch in his rice field; the water can then flow in the canal to the fields below. When the irrigation order is from the lower field to the upper field, the upstream farmer diverts all the water into his field and irrigation in the lower field is automatically stopped.

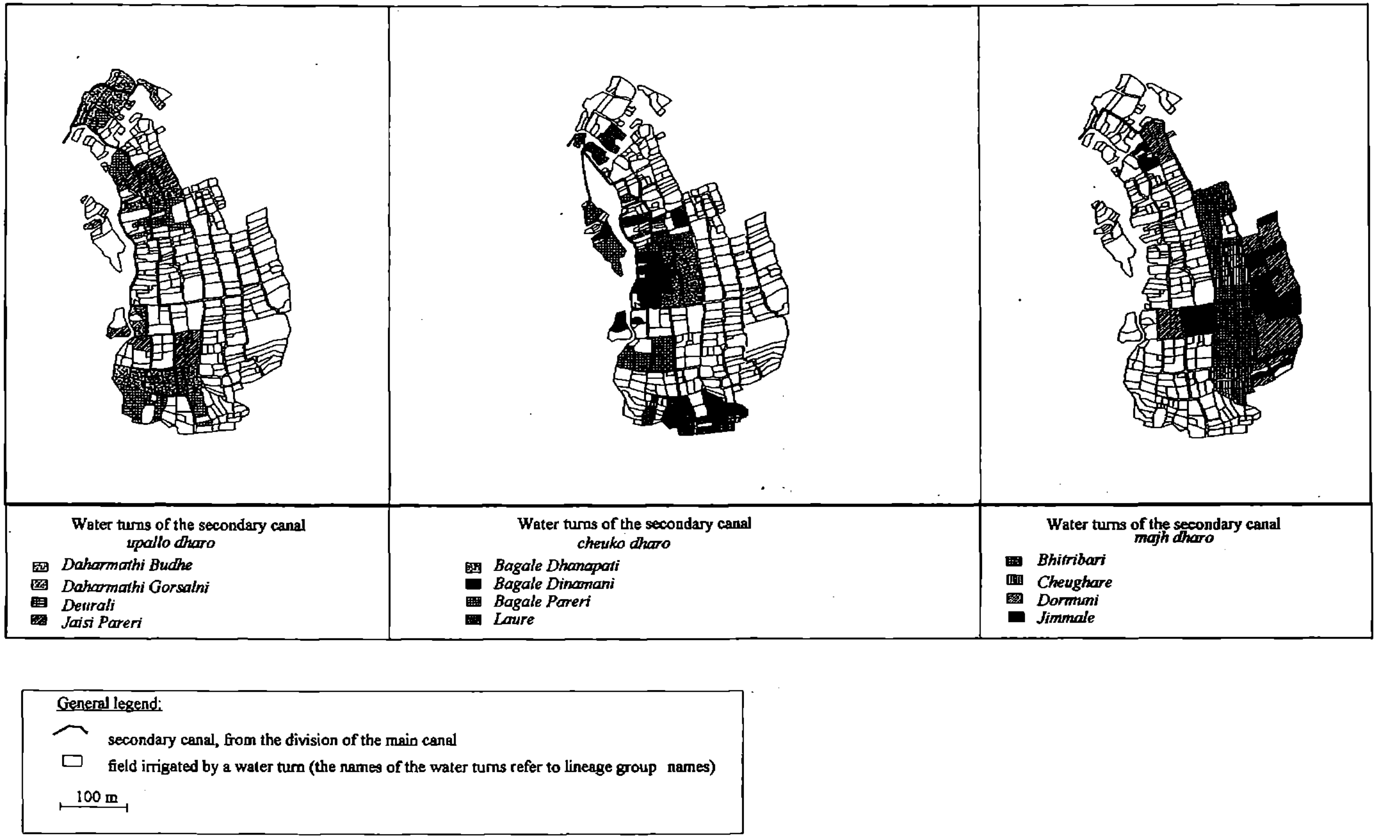

Water turns of the secondary canal
upallo dharo
▨ *Daharmathi Budhe*
▨ *Daharmathi Gorsalni*
▤ *Deurali*
▨ *Jaisi Pareri*
Water turns of the secondary canal
cheuko dharo
▨ *Bagale Dhanapati*
■ *Bagale Dinamani*
▦ *Bagale Pareri*
▩ *Laure*
Water turns of the secondary canal
majh dharo
▤ *Bhitribari*
▥ *Cheughare*
▨ *Dorumni*
■ *Jimmale*
General legend:
secondary canal, from the division of the main canal
field irrigated by a water turn (the names of the water turns refer to lineage group names)
100 m

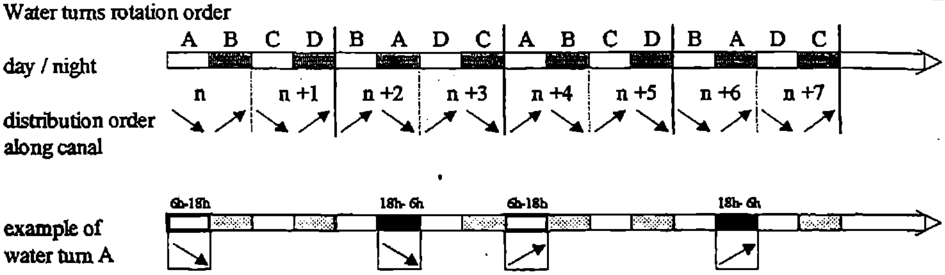
Figure 15.2: Water distribution and supply of village lands in Aslewacaur: spatial repartition of the water turns delivered by each of the three secondary canals.

The most peculiar element of this water distribution system is that individual water rights are defined in units of time. Indeed, the irrigation time granted to each canal user is meticulously counted with the help of a water clock *(paniko ghadi)*, designed so as to be proportional to the area to be irrigated. This water clock consists of a bowl with a small hole in its bottom, placed in another bucket full of water (see, Fig. 15.4 and photo). The water slowly enters the small bowl, which sinks when it is full, thus defining the time unit (*ghadi*). The operation lasts twenty-four minutes and must be repeated for measuring time continuously. This method of time measurement is very laborious: one man, the "guardian of the water clock" (*ghadi kuruwa*), used to be in charge of overseeing the water clock (the past tense is used here because everyone has a watch nowadays). He also informed each farmer of the exact timing of his irrigation turn. In practice, this man had to follow the distribution of irrigation water flow along the canal for the entire water turn, representing twelve hours every two days. Moreover, for the water clock to function correctly, the water in the bowl had to be very clean to prevent impurities from obstructing the hole and modifying the time measurement; therefore, during his watch, the guardian had to carry the water clock along the canal along with clean water.

Each farmer must irrigate his fields at a given time, according to the distribution schedule, which in a sense makes irrigation very constraining. For example, a farmer, Trilochan Pande, has a water right of two hours in the "Jaisi Pareri" water turn for plots located in the upper part of the irrigation network. If we suppose that this water turn is the turn "A" of Figure 15.3, the timing is as follows:

day x = 6:00 a.m. – 8:00 a.m.
day x+2 = 6:00 p.m. – 8:00 p.m.
day x+4 = 4:00 p.m. – 6:00 p.m.
day x+6 = 4:00 a.m. – 6:00 a.m.

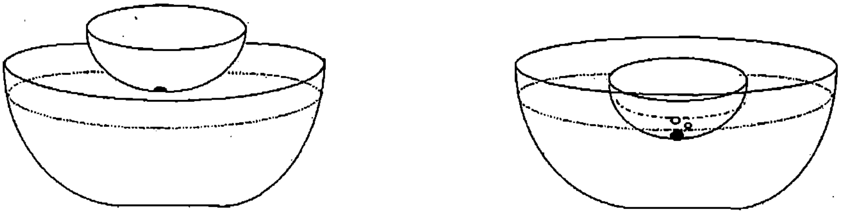
The water distribution in Aslewacaur can be therefore characterized as follows: water turns are organized according to kinship organization; this water distribution is based upon egalitarian rules (alternative distribution order between tail-end and head-end irrigators, water turns rotation order, measure of water rights); the distribution system follows a precise irrigation schedule characterized by the use of a water clock to determine individual water rights.



Remark: the arrows symbolise the order of water distribution along the canal:
the upstream field is first irrigated when the arrow points downwards,
the downstream field is first irrigated when the arrow points upwards.

In the upper part of the diagramme, the succession of four water turns of a secondary canal is shown. Below, the case of a single water turn clearly presents the intervals between irrigation periods. The total sequence lasts eight days.

Figure 15.3: Water turn schedule on secondary canal.


The bowl is put in water

It fills progressively with water through the small hole in its bottom

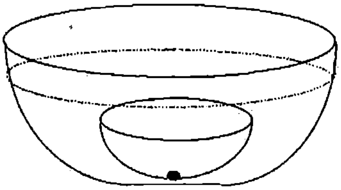

Then it sinks, one time unit is measured and the measurement operation has to be repeated

Figure 15.4: The water clock working diagram.

SPECIFICITY OF ASLEWACAUR AMONG VARIOUS APPROACHES OF WATER DISTRIBUTION IN NEPAL

In Nepal, traditional irrigation systems "exhibit a diversity of organizational structures and varying degrees of structural formality" (Yoder et al. 1987: 86). From this diversity (cf. the study of Pradhan 1989), characteristic methods of water distribution will be pointed out which commonly occur in the middle hills of Nepal. This will be done in order to demonstrate the special characteristics of the Aslewacaur irrigation system.

Generally speaking, water distribution based on water turns must be distinguished from free flow and liberal water access. Free flow enables farmers to access water whenever they wish it. In water turns systems, distribution rules and orders are defined.

In some areas it is possible to distinguish irrigation command areas, in others it is not possible. The former are often irrigated separately from each other, either receiving part of the flow, or receiving water for a duration, through a water turn, as in Aslewacaur. Such areas are geographically delimited as blocks of contiguous fields or are adjusted to land ownership and refer to social organization, for example, a lineage organization as in Aslewacaur. The linkage of land ownership divisions to kinship based[6] organizations, is in fact very common in Nepal. Fields of kinship groups are distributed in blocks and it is common to hear an explanation of the existence of four sectors of land, for example, as being the result of a division of land between four brothers, the ancestors of the present farmers.

In Aslewacaur, however, fields owned by a single lineage are scattered and do not form a continuous block. This unusual spatial organization of irrigation blocks may be explained by two facts: first that various kinds of land exist; and second that the land is divided on an egalitarian basis between brothers, and that this has been done for generations. Hence, each lineage has plots of each kind of land, at the top, middle and bottom of the network.

Water distribution does not correspond to the technical logic of water management. In this management system, water, indeed, must flow along the entire canal, both to the upper and lower fields, twice a day. This causes more water to be lost through seepage and evaporation than if water were allocated to adjoining irrigation sectors. Instead, we point out again, that the organization of water turns here follows a logic based upon kinship relations. This paper will not go further into the details of this lineage organization, but notes that a "social logic", as Bédoucha (1986) calls it, prevails over a technical one in this case of water management.

Generally speaking the distribution of water through irrigation command areas can be done either by volume, or time or both. The measure of volume through tanks, even if common in north India, is rare in Nepal and seems to be quite recent. Another distribution method consists of dividing the flow in a proportional manner by using a sluice.

The existence of sluice is mentioned in many irrigation systems in Nepal. Pradhan (1989) cites Cherlung and Argali in Palpa district, and Phalebas in Parbat district (near Gulmi district, see, Fig. 15.1). We have seen such proportioning weirs in many irrigation networks in the area of the Kali Gandaki (besides Argali, Cherlung and Phalebas, in Hasara, Macakot, Chehemi, Harmicaur,[7] and in the last built canal of Arbeni: see Fig. 15.1 for location). Martin and Yoder (1988: 171) mention the words *gahak* (a word used in Phalebas), *pani dhara* (literally "water spout") or *khat burda* (literally "wooden closure") used in western Nepal. Pinhorn (1988: 14) reports the use of a *saco* in an irrigation system in the Surkhet area, western Nepal. It has the particularity of having a piece of wood built into its top to prevent debris carried by the water from entering the irrigation network. In some cases, as in Damka (Gulmi district, along the Barigad River), the wooden proportioning weir is set up only during periods of water shortage, otherwise, irrigation is managed by a continuous flow system (Pradhan 1989: 87).

Proportioning weirs (*saco*) are cut from wood in the Aslewacaur area, but they can also be carved out of stone, as in Patan[8] (Baitadi district) in far western Nepal. Thus the use of a sluice is not particular to Aslewacaur.

Timed water distribution means water turn distribution in many irrigation systems of Nepal: one water turn lasts six or twelve hours, and farmers manage irrigation in a consensual way among themselves within that turn. The most specific element of Aslewacaur's water distribution is the use of a water clock to determine individual water rights. Indeed, the use of a water clock in irrigation seems uncommon in Nepal. The literature cites only two other examples in which a *ghadi* is used for water allocation, namely, the cases of Argali, in Palpa district, only a three-hour walk from Aslewacaur; and Cherlung, also in Palpa district, a two-hour walk from Argali. In these irrigation systems,[9] situated on river terraces above the Kali Gandaki River, a water clock is only used when the water supply is insufficient (Yoder et al. 1987: 44).

In Aslewacaur, however, there is no water shortage. After calculating the water balance of the rice fields, it was found that the canal delivers sufficient water to cover the needs of all the plots. Moreover, a water clock is used during the entire rice cultivation season, that is, even during the rainy season. There, the use of the *ghadi* seems not to be a response to water shortage as it is in Argali. A shortage of water may sometimes occur, however, due to the interruption of the water supply because of damage to the canal.[10] The use of a water clock can no way insure against the risk of water shortage caused by this type of accident and seems to have nothing to do with any inherent weakness of the canal. Moreover, the succession of water turns continues, even when water stops flowing in the canal because of such

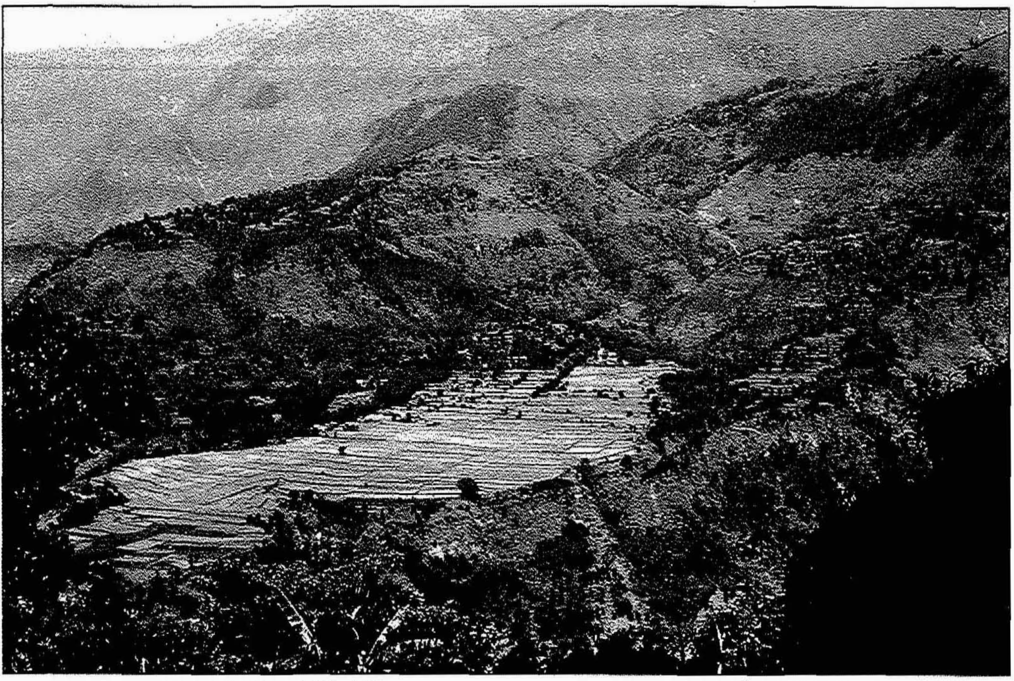


Photo 15.1: Aslewacaur, in the middle hills of central Nepal, is located at an elevation of 750 metres, on a high alluvial terrace cultivated in rice during the monsoon season (Olivia Aubriot. 1990).

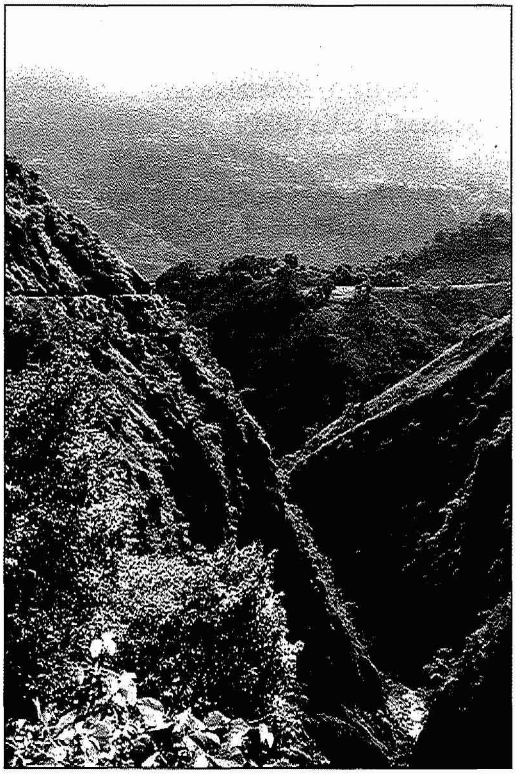


Photo 15.2: The water is diverted from a stream (seen at the bottom of the hill) and then channelled along a six-kilometre-long earth canal (on the photo's left side) Olivia Aubriot 1990).

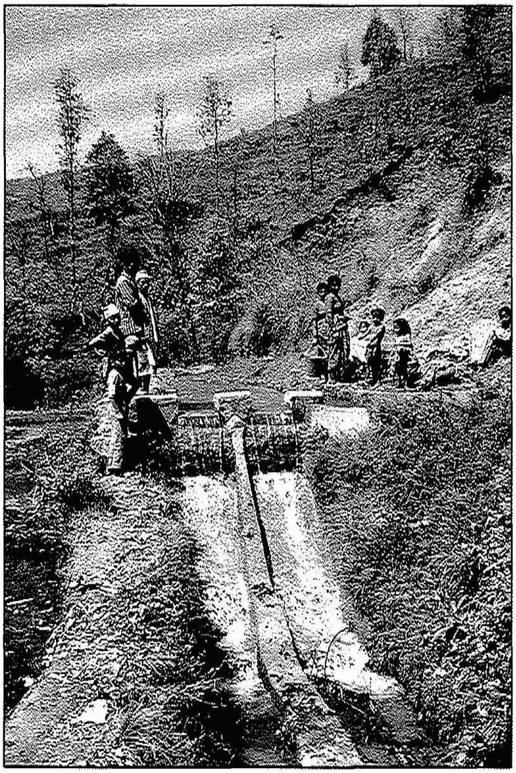


Photo 15.3: A proportioning weir divides the main canal into three secondary canals (the third notch is visible behind the low cement wall) (Olivia Aubriot 1990).

Photo 15.4: Irrigation is required to cultivate wet rice. Rice transplanting is done in muddy soil (Olivia Aubriot 1990s).

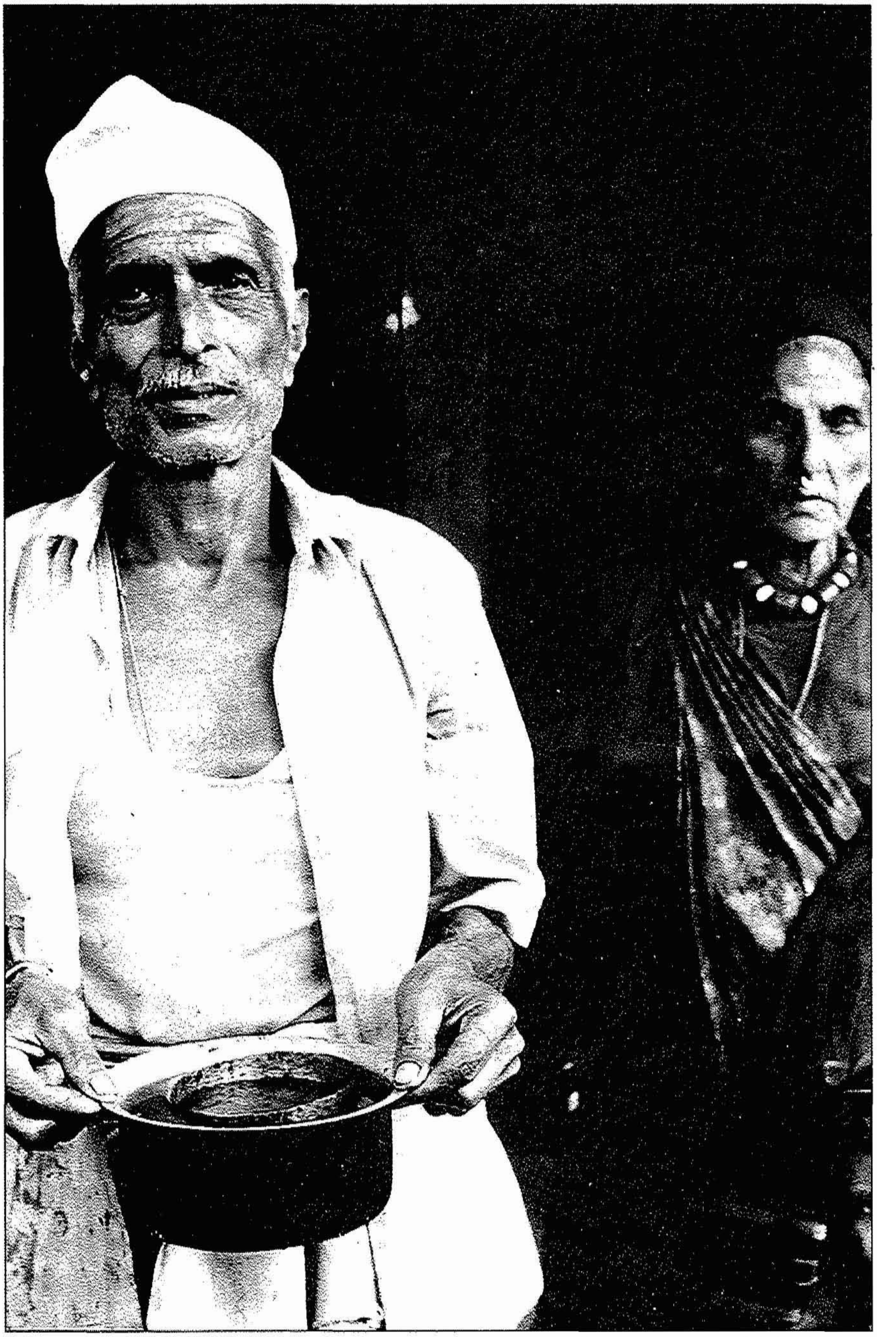


Photo 15.5: A water clock (*ghadi*), used here in irrigation, as well as in astrology (Olivia Aubriot 1990).

damage. Indeed, on such occasions, the sequence of turns does not resume at the place where it stopped, as is usually the case in other irrigation systems, irrigation resumes according to the irrigation schedule, as if nothing had ever interrupted the flow. The water clock does not even play a specific role on such occasions. This precision in the determination of water rights in Aslewacaur cannot be explained solely from an ecological point of view. Other factors must be considered.

The fact that the presence of this technique in Aslewacaur cannot be explained merely through ecological causes effects how one views techniques in the relation between man and his environment. As Bonte explains, societies are not constructed upon techniques, they have to exist first. Technical connections can then be established with nature (Bonte 1985: 22).[11] The technical process has thus to be analysed according to the social values placed upon the product, that appear to be presupposed elements of social life (Bonte 1985: 30). As for other technical facts, water distribution must be considered as a social fact, in order to understand its (social) efficiency.

SOCIAL EFFICIENCY OF THE TECHNIQUES

The term social efficiency can be demonstrated through the operation of this sort of complex water distribution system. The complexity of Aslewacaur system is the result of various economic, political and social reasons. We can mention for example a form of protection from neighbouring villages. The Aslewacaur villagers explain that "it is too difficult for outsiders to understand the irrigation system!" thus expressing their desire to keep this irrigated area for themselves, as well as their pride in being able to manage such a system. Indeed, it is also an expression of identity for Aslewacaur villagers, especially with regard to the neighbouring village of Aslewagaun, which is composed of members of the same clan. Through this expression, the villagers assert their identity and express their intellectual capacity for using and managing a complex irrigation system, for in Indo-Nepalese society, as in Indian society, especially among literate Bahun, manual activities are despised, while intellectual ones are prized. The complexity of the irrigation distribution schedule can thus be seen as a way of extolling the intellectual capabilities of the users.

The most important explanation of the use of the water clock in irrigation, however, is revealed by analysing the water distribution itself. Water sharing is based on two major principles. The first is the egalitarian sharing of water between lineages; that is each lineage receives the same amount of water even if the surface area differs slightly. The second principle refers to astrology. It is believed that the stars' positions influence humans and astrology intervenes in many occasions in the life cycle of individuals, such as choosing the most favourable wedding date; and also in the collective rhythm of the community, such as determining sowing dates or collective ceremonies. That is why the astrologer, who can reckon these influences and determine auspicious as well as inauspicious moments to commence an action, is often consulted. In India and Nepal, the water clock is an instrument used by astrologers to precisely calculate the most favourable time for offerings during these various ceremonies

In addition to the use of this instrument, the entire irrigation system is based on astrological references. The time unit is the *ghadi*, an astrological unit. Some measures of the zodiac are also used, for example, there are twelve water turns analogous to the twelve months of the year, and each of them last thirty *ghadi* as the measurement of each month on the zodiac is thirty degrees. The principle of water distribution is a rotation of water turns, and the irrigation schedule is like a continuous cycle that nothing can disrupt, even when water stops flowing due to damage to the canal. Astrology regulates the organization of water distribution and the life of the water users' group in the same way that human life is regulated by the heavens.

The astrological reference makes possible the harmony between technical work and cosmic organization. This technique, through its symbolic dimension, integrates the relation of man with the universe. This means that stars influence life patterns and in turn they also affect water distribution organization. If the use of the water clock in irrigation is not a response to ecological phenomena, it does, however, embody a cultural reference, and belongs to society. It has integrated the symbolic, conceptual framework of society.

TECHNICAL BORROWING

We have seen that the water sharing technique of Aslewacaur is not a response to ecological conditions. We also know that this method exists in the neighbouring village of Argali. Because of this and other reasons, we believe this technique was in fact borrowed from Argali. The Argali irrigation system is well known in the area, especially because of its location on the main route from Gulmi to Tansen, the headquarters of Palpa district. Moreover, its four long canals dug in the mountain are easily visible in the landscape. There, however, a water clock is only used when water shortages occur, as can be seen in irrigation systems of arid countries.

Indeed, the technique of water division using precise time units is very common in arid countries. In Tunisia for example, a water clock is composed of a bowl that empties itself (Bédoucha 1976). In Iran, various regionally specified systems for measuring time exist; a water clock similar to that of Aslewacaur, with time units lasting from five to twenty minutes, or another type similar to that described by Bédoucha but with longer units; a solar clock, consisting of a piece of wood used as a gnomon (Honari 1989; Stöber 1978: 147). Moreover, a detailed study has revealed that Aslewacaur and these other time-based systems have similar concepts of measurement used in water sharing (Aubriot, Jest and-Sabatier 1998). These points reveal that Aslewacaur's water division and the use of the water clock relates to arid zones, where water is very scarce and its management represents an essential element for successful agriculture. In Aslewacaur, however, water is not a scarce commodity.

Is it then possible to link the irrigation techniques observed in arid countries to that of Aslewacaur and to postulate that the distribution technique in Aslewacaur originates in those arid regions? Such a conclusion would be hasty given our present knowledge. We propose that this technique be linked to the Indo-Nepalese population, an immigrant population originating in northern India that introduced rice cultivation to central Nepal. But a comparative study is needed to establish the geographical distribution of this technique in northern India, the social conditions of its use, and its reference setting. Only then, can a hypothesis on the diffusion of this technique be refined.

In conclusion, a technique cannot be analysed without taking into account the intricacies of the social environment within which it is used. We have presented a water distribution technique that first of all cannot be explained by ecological necessity, and secondly, relates to water shortage conditions, although farmers are not confronted with water scarcity. As a technique, it can be understood only through its social efficiency, and especially its symbolic reference to astrology. Moreover, the presence of such a technique in Nepal alludes to the problems of diffusion of such a technique, notably in the case of migratory populations. Therefore, more analyses in this domain are needed.

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NOTES

1. A few Chhetri are present, but they belong to the same clan because their close ancestors were also Bahun: the children born from a union between a Bahun and a woman of lower rank, generally a Magar, have had their status downgraded to the rank of Chhetri.
2. The *thar* is a patronym used at the local level by patrilineal groups: it can thus be translated by the word clan.
3. *Upallo dharo* literally means "upstream fountain" and refers to the upper canal; the *majh dharo* is the middle canal and the *cheuko dharo* the canal of the edge.
4. The water turn names derive from lineage names: Bagale, Daharmathi, Deurali, Pareri and Jaisi. Bagale Dhanapathi and Bagale Dinamoni represent two branches of the lineage Bagale, Dhanapathi and Dinamoni being the elders' name for these branches. Budhe and Gorsalni are the names of the Daharmathi branches. Laure is a branch of the lineage Deurali. Bagale Pareri (and respectively Jaisi Pareri) means that the Bagale (and the Jaisi) bought the land from the Pareri. Bhitribari, Cheughare, Dormuni and Jimmale are branches of the Jaisi lineage.
5. A strict correspondence between water turns and lineage units, however, does not exist (a lineage may be at the origin of two water turns or of four water turns).
6. Land distribution is very often marked by patrilineal filiation and virilocal residence, the sons living on and inherits paternal land on an egalitarian basis, whereas the daughters leave the village and live with their husband's family.
7. In Harmicaur, as in Argali and Cherlung, there are many proportioning weirs with several notches, delivering water to the various irrigation blocks, sometimes even to field level. In other places, the sluice is located just at the head of the command area, engendering secondary canals. Moreover, if the sluice is commonly used in the area of the Kali Gandaki, it is not known in the western part of Gulmi district. A more detailed study on the diffusion of this method should be undertaken before advancing any hypothesis on this subject.
8. There, water is first divided into nine parts for domestic needs by a wooden proportioning weir (eight of these parts supply a richly carved fountain, which has a separate spout upstream for the Untouchables). Then, the remaining water is collected and divided again into four parts for irrigation use, but with a stone proportioning weir. The sculpted

fountain is similar to that in Ajayamerakot (Dadeldhura District), where some inscriptions on the temple indicate that these monuments were built at the end of the fourteenth century (Pandey, Sharma and Aubriot 1993). These elements do not indicate the date of the use of the stone sluice, but suggest it is quite old. However, we do not know how to interpret the fact that the proportioning weir before the fountain is wood and the one used for irrigation is stone: is it to impose a fixed division of irrigation water?

9. Argali is an irrigation network that would have been built on the initiative of Mukunda Sen, a king of Palpa who reigned during the first half of the sixteenth century.
10. The geological structures observed along the irrigation canal in Aslewacaur consist of metasedimentary rocks: grey dolomite; pink phyllitic slate, calcareous slate and ripple-marked quartzite; dark grey slate, carboneous slate with calcareous bands. The last two kinds of rocks, associated with steep slopes and surface drainage seepage, are particularly subject to land stability deterioration (Dongol 1991).
11. The full quotation of the original text reads as follows: "Que les relations avec la nature par l'intermédiaire des techniques soient sources d'expériences qui permettent d'attribuer des significations à certains comportements sociaux et culturels mérite réflexion, mais peut-on directement déduire ces significations des systèmes techniques? Les sociétés ne se construisent pas à partir de ces expériences, ni même à partir de ces techniques. Il faut que les sociétés existent pour que puisse être établi ce rapport technique avec la nature et que puissent en être déduites des significations." (Bonte 1985: 22).

16

Legal Aspects of Water Rights in Bhutan

Corneille Jest

The Kingdom of Bhutan, located in the eastern part of the Himalayan range, covers an area of 46,500 kilometres extending approximately from 26°45' to 28°20' North and 88°50' to 92°05' East. The country is mountainous with elevations reaching up to 7000 metres. The climate is sub-tropical with an annual rainfall of more than 2000 millimetres of which 80 per cent occurs between June and September. Ninety-five per cent of the population of approximately 700,000 is dependent on agriculture. Only 8 per cent of the total land is cultivated with an estimated 38,733 hectares under irrigation.[1]

The farming systems are adapted to the environment, climatic conditions and the peoples' needs. Rice and maize are the main cereals and are grown in all zones except the western cool temperate zone where wheat, buckwheat, potatoes and barley are produced instead. Where irrigation is available, wet land crops in winter include wheat, mustard and potatoes.

Irrigation in Bhutan is geared primarily towards rice cultivation. Flat terraces have had to be constructed to allow inundation. Regional variations have been observed by Karan (1990: 66):

> Bench terracing is generally more widespread in the interior valleys, while natural slope fields or slightly terraced fields predominate in southern Bhutan. The most advanced type of terracing is the flat bench variety with retaining stone walls which look like contour lines as they bend with the directional change in the slopes.

Besides terracing, the seasonal availability of irrigation water forms a major precondition for wet land farming. Good distribution of water is needed especially during the periods of water scarcity before the monsoon.

The irrigation systems are organized to ensure the acquisition of the water, its distribution, its allocation to farmers, and labour for the maintenance of the network of canals. Maintenance is the responsibility of the beneficiaries under the leadership of a village elder, elected by the heads of the households to carry out certain functions, primarily during the three months when there is water scarcity. This elder organizes the desilting and maintenance of the canals and solves any conflicts which might occur during the distribution of the water shares.

In Bhutan, the weight of tradition is important and water management has its place in the Code of Laws, *Druk ki Thrimzhung*. This paper discusses the rules of water management collected in different districts and put into written form by the High Court in 1957. These rules are based on oral tradition and daily practice.

The dynamics of management are reflected in chapter 7 of the "Laws concerning the Soil", *Sa'i thrim yig*, presented in Volume Ka; a chapter devoted to water channels, embankments and roads. A translation of each legal paragraph is followed, in each case, by a short summary of its contents.

Ka 7.1 – For the benefit of one's landed property, house and *Jashing*[2] etc., construction of new irrigation channels and embankments is permissible when such construction does not cause damage to another's landed property, house and *Jashing* etc. (cf. Thrimzhung Ka 1.6, 1957). New irrigation channels and embankments can only be constructed where such construction does not effect others.

Ka 7.2 – For the benefit of landed property, *Jashing* etc., renovation of existing irrigation channels and embankments can only be done on existing alignments. If renovation work is carried out in this manner, nobody can object to it, even if it affects them (cf. Thrimzhung Ka 1.7, 1957). Renovation of existing irrigation channels and embankments can be carried out even if it affects others.

Ka 7.3 – The size of existing roads and irrigation channels passing through one's landed property cannot be diminished nor can they be blocked even if they are no longer required by the owner. Defaulters will be fined Nu. 50 to Nu. 300 (cf. Thrimzhung Ka 1.10, 1957). Existing roads and irrigation channels cannot be damaged even if these pass through one's landed property.

Ka 7.4 – Construction of new irrigation channels and embankments for the benefit of one's house, land, *Jashing*, etc., which effects the landed property and house of other's cannot be carried out without obtaining permission from the local court. A fine of Nu. 100 To Nu. 600 can be imposed on the defaulter by the local court depending upon the seriousness of the damage to the land; whatever activities already planned will be treated as null and void (cf. Thrimzhung Ka 1.10, 1957). Construction of new irrigation channels and embankments is not allowed without permission where these effect others.

Ka 7.5 – The Thrimkhang's permission has to be obtained for the construction of new irrigation channels and embankments on one's own property for the benefit of one's own land, house, *Jashing* etc., if such construction effects others. In default, a sum of Nu. 50 to 300 will be imposed as fine besides requiring that the construction be demolished. Permission has to be sought for construction of new irrigation channels and embankments even on one's own land if such construction effects others.

Ka 7.6 – If water has not flowed through old irrigation channels and no repairs have been carried out on the embankments in the last five years, then any renovation or repairs carried out on the existing alignment will be treated as new construction. (cf. Thrimzhung Ka 1.11, 1957). Renovation of old irrigation channels and embankments left unrepaired for five years will be treated as new construction.

Ka 7.7 – The sharing of water from an irrigation channel will be allocated among beneficiaries either though mutual understanding or existing practices. In other cases, water should be divided among the landholders served by the channel, according to the size of their land holding and the amount of water in the channel. This excludes landholders covered under Ka 7.9 and Ka 7.10. Entitlement through prior claims will not be entertained. Entitlement of water shares to the beneficiaries of an irrigation channel is defined.

Ka 7.8 – Division of labour between the beneficiaries of a channel will be proportional to the size of each land holding. Defines the proportional nature of the division of labour between the beneficiaries of a channel.

Ka 7.9 – One must consider the sufficiency of water available in a channel before allowing the conversion of a *Kamshing* into a *Chhushing*. Defines a requirement that sufficient water exists before a newly terraced paddy field can be created.

Ka 7.10 – If one has created a paddy field knowing that there is insufficient water in a channel, he cannot complain that there is no water in his field, whether or not he has worked on the channel. States that additional water will not be allocated to new paddy fields (unless there is a surplus).

Ka 7.11 – If there is sufficient surplus water in an existing channel the beneficiaries of the channel will provide water to an individual who wishes to convert a *Pangshing* to a *Chhushing* or to one with a new allotment from the Government, without any objection. The owner of the new paddy field will then join in contributing his proportional labour share the maintenance of channel like other beneficiaries. Defines the availability of water for creating new paddy fields.

Ka 7.12 – One cannot neglect one's own irrigation channel and claim water from another channel without entering into a separate agreement with the beneficiaries of that channel. In the absence of such an agreement, one cannot claim the use of water on the ground that his own channel is far away from his land. Defines the use of water from others' channels without agreement due to neglect.

Ka 7.13 – As per Ka 7.12, if an old channel cannot be rehabilitated, then water from another channel can be used if there is sufficient water in accordance with Ka 7.11. Defines the right of use of an irrigation channel in the absence of alternatives.

Ka 7.14 – If both upper and lower paddy fields are old and ongoing practice requires that water for the lower plot passes through the upper plot, the owner of the upper plot, without any objection, should permit water to flow through his field to irrigate the lower plot. If the lower plot is newly terraced, if possible, the water channel should be aligned so as not to effect the upper plot: otherwise, the channel should be aligned according to the wishes of the owner of the upper plot.

If a new paddy field is created above an old paddy field close to the water source and water can only be brought to the old field through the new field, then water can be brought through the new field if it is sufficient. If there is insufficient water, however, then as per Ka 7.9 and Ka 7.10, the new field will not be allowed water. Defines the entitlements for water between upper and lower and/or new and old plots.

COMMENTS

In an interview, the Chief Justice of Bhutan, Dasho Sonam Tobgye, commented that the defining rules of the Code are as follows:

- the existing systems have priority in case of later changes,
- local practices must be considered as guidelines,

- a new construction is authorized only if it does not interfere with existing rights,
- when cropping patterns are modified, water rights can be denied
- traditional rights supersede new requests
- productivity is not the determining factor in getting water.

Viewing irrigation practice from the legal point of view it becomes evident that the legislators have placed emphasis on the conservation of existing irrigation systems, as well as protecting farmers and their traditional farming systems. Changes are authorized for non-continuous use of existing channels and the construction of new ones. Modifications are possible when cropping patterns and the nature of crops change. The Code for Water Management in Bhutan protects traditionally irrigated village lands but also opens the door for the extension of cultivation. These hierarchies of water laws do exist in many cases in the Himalaya Hindukush area.

THE DEVELOPMENT OF IRRIGATION IN BHUTAN

Bhutan's economy is based on agriculture and a policy of self-sufficiency with regards to food grains. The importance of irrigation in achieving this objective is evident. After the introduction of planned development, farmer-managed irrigation systems began to receive support from the government. The Ministry of Agriculture is now engaged in the constructing and rehabilitating irrigation systems throughout the country. Major irrigation projects, such as the Chirang Hill irrigation development project (Asia Development Bank), and the Gelephug Lift Irrigation Project (UNCDF) are funded through external resources.

With the introduction of technical and financial aid on a big scale, the need for a fundamental realignment of approach to irrigation development has become apparent in recent years. The Department of Agriculture developed the National Irrigation Policy in 1991, which has introduced several new approaches considered necessary to ensure the viability of the infrastructure. The final document incorporates recommendations as well as national goals. As irrigated agriculture continues to move more into high-value cash crops, pastures and lift systems, policy measures will undoubtedly continue to change to incorporate appropriate modifications.

I would like to express my thanks to Dasho Sonam Tobgye, Chief Justice, for his kind help and advice on matters concerning the jurisdiction of water management in Bhutan.

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NOTES

*Fieldwork for this study was executed in 1994.

1. According to the Land Use Planning Project, Bhutan, for 1995 the nature of the cultivated area is as follows: wet land 12 per cent, dry land 52 per cent, shifting cultivation 28 per cent, other 8 per cent. Agricultural production statistics (1990): paddy 55.4 metric tons; maize 69.3 metric tons; barley 4.6 metric tons. Source: Land Use Planning Project, Ministry of Agriculture, Bhutan 1991.
2. *Jashing* or *rgya-shing*: field on flat land, cultivated each year, *kamshing, skam-shing*: literally dry land, rain-fed field, *chushing, chu-shing*: wet land, irrigated paddy field, *pangshing, spang-shing*: grass field on a slope, can be left fallow for one or two years, *tseri, rtsha-ri*: shifting cultivation land, field which can be left fallow for more than two years.

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